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Journal of the Society of Arts.

No. 1513.] *FRIDAY, NOVEMBER* 18, 1881. [*Vol. XXX.*

ONE HUNDRED AND TWENTY-EIGHTH SESSION, 1881-82.

COUNCIL.

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Sir Frederick J. Bramwell, F.R.S., *Vice-Pres. and Chairman of Council.*

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ASSISTANT SECRETARY.	*ACCOUNTANT.*	*AUDITOR*
Henry B. Wheatley, F.S.A.	Howard H. Room.	J. Oldfield Chadwick.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Twenty-Eighth Session of the Society was held on Wednesday, the 16th November, when the Opening Address was delivered by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council. Previous to Christmas there will be Four Ordinary Meetings, when papers will be read by Prof. Sylvanus Thompson, Mr. J. A. Berly, Capt. Douglas Galton, C.B., F.R.S., and Mr. W. H. Preece, F.R.S., and also meetings for the discussion of the Society of Arts' Patent Bill.

ORDINARY MEETINGS.

Wednesday evenings at Eight o'clock. For evenings before Christmas:—

November 16.—Opening of the Session. Address by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council.

NOVEMBER 23.—"Storage of Electricity." By Prof. SYLVANUS THOMPSON, D.Sc.
NOVEMBER 30.—"The Distribution of Time by a System of Pneumatic Clocks." By J. A. BERLY. Lord ALFRED S. CHURCHILL will preside.
DECEMBER 7.—"The American System of Heating Towns by Steam." By Capt. DOUGLAS GALTON, C.B., F.R.S.
DECEMBER 14.—"Electric Lighting at the Paris Electrical Exhibition." By W. H. PREECE, F.R.S.

For meetings after Christmas:—

"Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.
"Stained Glass Windows." By LEWIS FOREMAN DAY.
"Photometric Standards." By HAROLD DIXON.
"Telephonic Communication." By LIEUT.-COL. C. E. WEBBER.
"The Causes and Remedies of Bad Trade." By WALTER R. BROWNE, M.A.
"The Native Tribes of the Hudson's Bay Territories." By DR. RAE, F.R.S.
"The Manufacture of Ordnance." By COLONEL MAITLAND.
"Some Practical Aspects of Recent Investigations in Nitrification." By R. WARINGTON.
"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON.
"Gas for Lighthouses." (Illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN WIGHAM.
"The Relation of Botanical Science to Ornamental Art." By F. EDWARD HULME, F.L.S., F.S.A.
"The High-pressure Steam-engine." By LOFTUS PERKINS.
"The Industrial Resources of Ireland." By G. PHILLIPS BEVAN.
"A New Antiseptic Compound and its Application to the Preservation of Food." By PROF. BARFF, M.A.
"Tonnage Measurement." By ADMIRAL SIR R. SPENCER ROBINSON, K.C.B., F.R.S.
"Tools and Cutting Edges." By D. A. AIRD.
"The Teaching of Forestry." By COLONEL G. F. PEARSON.
"The Art of Turning." By P. W. HASLUCK.
"Recent Researches into the Theory of the Living Contagium and their Application to the Prevention of Certain Diseases in Animals." By J. L. W. THUDICHUM, M.D.
"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS, F.C.S., and PERCY C. GILCHRIST, F.C.S.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 31; February 28; March 21; April 4, 25; May 23.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 26; February 23; March 9, 30; April 27; May 11.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 17; March 17, 31; April 21; May 12, 26.

CANTOR LECTURES.

The First Course will be on "Some of the Industrial Uses of the Calcium Compounds." By THOMAS BOLAS, F.C.S.

November 21, 28; December 5, 12.

The Second Course will be on "Recent Advances in Photography." By CAPTAIN ABNEY, R.E., F.R.S.

January 30; February 6, 13, 20.

The Third Course will be on "Hydraulic Machinery." By PROF. JOHN PERRY.
March 6, 13, 20, 27.

The Fourth Course will be on "Book Illustration, Old and New." By J. COMYNS CARR.
April 20; May 1, 8, 15.

Syllabus oj the First Course.

LECTURE I.—Distribution and occurrence of calcium in nature. Carbonate of lime as limestone, chalk, marble, calcspar, shells, &c. Notes on some of the calcium minerals. Short survey of the chemistry of calcium and of its derivations.

LECTURE II.—Lime. The calcination of the carbonate in theory and practice. Influence of foreign bodies on the quality of the lime. Most favourable conditions for the decomposition of pure and impure forms of calcium carbonate. Cements and their uses. Lime as a refractory material. Lime-light. The oxy-hydrogen furnace. Lime moulds for the casting of iron and steel. Notes on a few of the industrial and economic uses of lime.

LECTURE III.—Sulphate of lime and its occurrence in nature. Gypsum and alabaster. Plaster of Paris, its preparation and uses. Physical and chemical aspects of the setting of plaster. Accelerating and retarding influences. Scientific principles involved in some of the applications of plaster. Moulding, stereotyping, and other processes.

LECTURE IV.—Other calcium compounds and their uses. The phosphorescent sulphide. Lime soaps. Bleaching powder. Phosphates of calcium. Organic calcine salts. The hardness of water, &c.

In connection with Capt. Abney's Lectures, it is intended to arrange for an exhibition of photographic apparatus, processes, &c.

JUVENILE LECTURES.

The two Juvenile Lectures will be by W. H. PREECE, F.R.S., on "Recent Wonders of Electricity." The dates for these are Wednesday evenings, December 28 and January 4. The lectures will commence at 7 o'clock. Special tickets will be issued for these lectures.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED CHEMISTRY AND PHYSICS SECTION.—This Section was formed in 1874, for the discussion of subjects connected with Practical Chemistry and its applications to the Arts and Manufactures. It was enlarged in 1879, so as to include the consideration of subjects connected also with the Applications of Physical Science to the Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are Three or more Courses every Session, and each course consists generally of from Three to Six Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—The Society's Examinations now comprise the following divisions:—1. Political Economy. 2. Domestic Economy—(*a*) Cooking; (*b*) Clothing; (*c*) Health; (*d*) Housekeeping and Thrift. 3. Music—(*a*) Theory; (*b*) Practice. 4. Elementary. The Programme for 1882 can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.
To be present and vote at all General Meetings of the Society.
To be present at the Cantor and other Lectures, and to introduce one visitor.
To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi.
To be present at all the Society's *Conversazioni*.
To receive a copy of the Weekly *Journal* published by the Society.
To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

All subscriptions should be paid to the Secretary, H. T. Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

H. TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1881-82. It is issued subject to any necessary alterations:—

NOVEMBER, 1881.		
1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	Ordinary Meeting. (Opening Meeting of the Session.)
17	Th	
18	F	
19	S	
20	**S**	
21	M	Cantor Lecture I. 1
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture I. 2
29	Tu	
30	W	Ordinary Meeting

DECEMBER, 1881.		
1	Th	
2	F	Special Meeting. (Discussion on Patent Bill)
3	S	
4	**S**	
5	M	Cantor Lecture I. 3
6	Tu	
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	Cantor Lecture I. 4
13	Tu	
14	W	Ordinary Meeting
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	Christmas Day
26	M	Bank Holiday
27	Tu	
28	W	Juvenile Lecture 1
29	Th	
30	F	
31	S	

JANUARY, 1882.		
1	**S**	
2	M	
3	Tu	
4	W	Juvenile Lecture 2
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	Ordinary Meeting
12	Th	
13	F	
14	S	
15	**S**	
16	M	
17	Tu	
18	W	Ordinary Meeting
19	Th	
20	F	
21	S	
22	**S**	
23	M	
24	Tu	
25	W	Ordinary Meeting
26	Th	Chem. & Phys. Sec.
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture II. 1
31	Tu	For. & Col. Section

FEBRUARY, 1882.		
1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	**S**	
6	M	Cantor Lecture II. 2
7	Tu	
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	**S**	
13	M	Cantor Lecture II. 3
14	Tu	
15	W	Ordinary Meeting
16	Th	
17	F	Indian Section
18	S	
19	**S**	
20	M	Cantor Lecture II. 4
21	Tu	
22	W	Ordinary Meeting
23	Th	Chem. & Phys. Sec.
24	F	
25	S	
26	**S**	
27	M	
28	Tu	For. & Col. Section

MARCH, 1882.		
1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	**S**	
6	M	Cantor Lecture III. 1
7	Tu	
8	W	Ordinary Meeting
9	Th	Chem. & Phys. Sec.
10	F	
11	S	
12	**S**	
13	M	Cantor Lecture III. 2
14	Tu	
15	W	Ordinary Meeting
16	Th	
17	F	Indian Section
18	S	
19	**S**	
20	M	Cantor Lecture III. 3
21	Tu	For. & Col. Section
22	W	Ordinary Meeting
23	Th	Chem. & Phys. Sec.
24	F	
25	S	
26	**S**	
27	M	Cantor Lecture III. 4
28	Tu	
29	W	Ordinary Meeting
30	Th	
31	F	Indian Section

APRIL, 1882.		
1	S	
2	**S**	
3	M	
4	Tu	For. & Col. Section
5	W	
6	Th	
7	F	Good Friday
8	S	
9	**S**	Easter Sunday
10	M	Bank Holiday
11	Tu	
12	W	
13	Th	
14	F	
15	S	
16	**S**	
17	M	
18	Tu	
19	W	Ordinary Meeting
20	Th	
21	F	Indian Section
22	S	
23	**S**	
24	M	Cantor Lecture IV. 1
25	Tu	For. & Col. Section
26	W	Ordinary Meeting
27	Th	Chem. & Phys. Sec.
28	F	
29	S	
30	**S**	

MAY, 1882.		
1	M	Cantor Lecture IV. 2
2	Tu	
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	**S**	
8	M	Cantor Lecture IV. 3
9	Tu	
10	W	Ordinary Meeting
11	Th	Chem. & Phys. Sec.
12	F	Indian Section
13	S	
14	**S**	
15	M	Cantor Lecture IV. 4
16	Tu	
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	**S**	
22	M	
23	Tu	For. & Col. Section
24	W	Ordinary Meeting
25	Th	
26	F	Indian Section
27	S	
28	**S**	Whit Sunday.
29	M	Bank Holiday
30	Tu	
31	W	Ordinary Meeting

JUNE, 1882.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	
6	Tu	
7	W	Conversazione at the South Kensington Museum
8	Th	
9	F	
10	S	
11	**S**	
12	M	
13	Tu	
14	W	
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	
26	M	
27	Tu	
28	W	Annual General Meeting
29	Th	
30	F.	

The chair will be taken at eight o'clock at each of the above meetings, except the Annual General Meeting and the Juvenile Lectures.

The Annual General Meeting will be held at four o'clock.

The Juvenile Lectures will be given at seven o'clock.

NOTICES.

PATENT LAW DISCUSSION.

The Discussion on the Society of Arts' Patent Bill will not be held on Wednesday, November 30th, as previously announced, but on Friday, December 2nd.

The discussion will be opened by Sir Frederick Bramwell, F.R.S, Chairman of the Council, and will be continued on such evenings as may be found convenient.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

In connexion with the course of Cantor Lectures, which will be delivered by Captain Abney, F.R.S., on "Recent Advances in Photography," in January and February next, it is proposed to hold, in the House of the Society of Arts, an Exhibition of Photographic Appliances.

The dates of Captain Abney's Lectures are January 30th, February 6th, 13th, and 20th. The Exhibition will be kept open from January 30th till about the end of February.

The Exhibition will be of a technical character, and it is not, therefore, desired to collect photographs of artistic merit only.

The following are among the principal classes of objects sought for exhibition:—

Apparatus: cameras, lenses, tents, instantaneous shutters, slides, sensitometers, lamps (intended specially for photographic purposes), enlarging apparatus, printing and mounting apparatus, &c.

Photographic materials.

Illustrations of new processes; negatives and prints produced by new or special processes.

Appliances used in reproductive processes; specimens of illustrations produced by such processes; specimens of historical interest, as illustrations of old processes.

Lighting: models illustrative of characteristic features in the construction of glass houses; methods of fixing glass without putty or similar material; arrangements for the production of artificial light for photographic purposes.

Any person wishing to exhibit any of the above is requested to communicate with the Secretary of the Society, who will supply printed forms of application for space, and will be glad to give any further information required.

It is hoped that arrangements may be made for showing the actual working of some of the more recent processes.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

ELECTRIC LIGHTING AT THE SAVOY THEATRE.

On Saturday afternoon last (12th inst.), a considerable number of the Council and Members of the Society were enabled, through the kindness of Mr. D'Oyly Carte, the proprietor, to inspect the lighting arrangements adopted at the Savoy Theatre. The Chairman of the Council and the Members were received by the manager and the engineer, who showed them over the building. The theatre is lighted with Swan's incandescent lamps, which are supplied by Siemens's alternating current machines. At present, the auditorium only is lighted with the electric light, but arrangements are being made for lighting the stage by the same means. The light was lowered several times, and the appliances by which this was effected were shown. The shed on the Embankment, which contains the steam-engine and dynamo-machines, was also visited.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 16th, 1881; Sir FREDERICK J. BRAMWELL, F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Arbib, Enrico, 5, Craven-hill, Hyde-park, W.
Bell, Sir F. Dillon, 7, Westminster-chambers, S.W.
Bowes, John, Ph.D., F.R.G.S., Warrington.
Cafferata, Redmond Parker, Newark-upon-Trent.
Carey, R. Richard, Camperdown-house, Snow's-fields, S.E., and New Western-street, Bermondsey, S.E.
Cassels, Herbert Wentworth, 51, Cleveland-sq., W.
Cater, John James, 39, Lombard-street, E.C., and Liston-house, Wimbledon, Surrey.
Chadwick, John, Vale-house, Greaves-street, Oldham.
Chalmers, John Reid, 7, Noel-street, Islington, N.
Chegwyn, Joseph T. W., Elm-lodge School, Streatham, S.W.
Child, Rev. Alfred, M.A., Therapia, Branksome-park, Bournemouth.
Church, George Frederick, 5, Wilmington-square, E.C.
City and Guilds of London Institution (Director and Secretary), Gresham College, E.C.
Clark, Henry, Gas Light and Coke Company, Great Cambridge-street, Hackney-road, E.
Cripps, Samuel George, Orsett College, Essex.
Crompton, R. E., Mansion House-buildings, E.C.
Dalman, Tomas José, 10, Rambla Canaletas, Barcelona.
Davison, Major Thomas, 16th Lancers, York.
Deane, Major George, Junior United Service Club, S.W., and 56, Warwick-road, S.W.
Downes, Commissary-General, 28, Charleville-road, West Kensington, S.W.
Eastick, John Joseph, F.C.S., 15, Trinity-square, E.C.
Elkington, Leigh H., F.C.A., 71, Francis-road, Edgbaston, Birmingham.
Elmore, William, 91, Blackfriars-road, S.E.
Francis, Gerald Beaufoy, 31, Craven-street, Strand, W.C.
Fraser, Alexander Colvin, Gas Offices, Bolton.
Griffith, Frederick, A.M.I.C.E., 43D, Regent-street, Leicester.
Hallett, H. H., Alderman, 141, Marine-parade, Brighton.
Halkett, Ralph, Gas Works, Bicester.
Hiddingh, Michael, F.C.S., Newlands, Cape of Good Hope.
Hill, Joseph, 97, Larkhall-rise, Clapham, S.W., and Crown Works, South Lambeth, S.W.
Hutchinson, Charles Henry, Church-street, Barnsley.
Inglis, John, 14, Praya Central, Hong Kong.
Izat, Alexander, A.M.I.C.E., Lenzie, near Glasgow.
Jessop, Maurice Ernest, 18, Elgin-crescent, Notting-hill, W.
Justice, Philip M., 14, Southampton-buildings, Chancery-lane, W.C.
Kirby, Edmund A., M.D., Kelsey-park, Beckenham, Kent.
Klenk, J. M., Sunnyside, Clapham-common, S.W.
Labouchere, James, 23, Chapel-street, Belgrave-square, W.
Lee, John Dunkin, The Oak, Belvedere-park, Kent.
Lee, William, Downside, Leatherhead, Surrey, and 110, Cannon-street, E.C.
Lloyd, Richard, 2, Addison-crescent, Addison-road, Kensington, W.
Lloyd, William Henry, Hall-green, Wednesbury.
Lomas, Thomas George, the Hollies, Wellington-road, Whalley-range, Manchester.
Maclean, J. M., Malabar-villa, Grove-park, Chiswick.
Manton, Henry, jun., Northfield, near Birmingham.
Martin, Henry Austin, M.D., Boston, United States, America.
Melles, Joseph William, M.A., 3, Cripplegate-buildings, E.C., and Stewardstone, Chingford, Essex.
Milward, James, 54, Charles-street, Cardiff.
Mitchell, Thomas, F.R.I.B.A., Alexandra-park, Oldham.
Northall-Laurie, Reginald, 7, Stratton-street, W.
Oates, Eugene W., 6, Tenterden-street, Hanover-square, W.
Paget, Berkeley, 20, Lexham-gardens, Cromwell-road, S.W.
Peake, John, 65, Colebrooke-row, Islington, N.
Perry, Robert, Vernon-house, Spring-grove, Isleworth.
Prager, Alfred J., L.D.S., 351, City-road, E.C.
Reddie, Arthur Williams Lovell, 66, Chancery-lane, W.C.
Reed, Henry, 14, Union-street, Portsea, Hants.
Ricci, L., 15, Frithville-gardens, W.
Richmond, Henry, Haringey-park, Crouch-end, N.
Scott-Moncrieff, W. D., C.E., 1, Fairholme-road, Kensington, S.W.
Seymour, W. Hamilton, the Clyde Steam Printing Works, Howard-square, Glasgow.
Short, John, Sutherfield-house, 101, Abbey-road, N.W.
Single, John Godfree, A.M.I.C.E., care of Messrs. Grindlay, Groom & Co., Bombay.
Slight, George Henry, 413, East-India-road, Poplar, E.
Stubbs, William, Phœnix Wharf, Commercial-road, Lambeth, S.E.
Tanner, Henry, M.R.A.C., F.C.S., 19, St. Oswald's-road, West Brompton, S.W.
Thomas, William, 27, Victoria-road, Kentish-town, N.W.

Thurkle, Edward, 7, Denmark-street, Soho, W.C.
Usher, Joseph, 25, Barnsbury-park, N., and 105, St. John-street-road, E.C.
Verney, Captain Edmund W., R.N., Rhianva, Bangor, and Travellers' Club, S.W.
Wetter, Jasper, 67, Strand, W.C.
Wiggin, Henry, M.P., Metchey-grange, Harborne, near Birmingham.
Wild, Joseph H., 53, Emma-place, Stonehouse, Plymouth.
Wood, William Martin, 25, Castletown-road, West Kensington, S.W.
Xifra, Narciso, 24, Mendizaba, Barcelona.

The CHAIRMAN delivered the following

ADDRESS.

My colleagues have been good enough to confer on me the honour ordinarily accorded to their Chairman, that of a second year's nomination to the office, and thus it has become my duty to open the Session by an address; and in doing so, I propose that my principal topics shall be some of the applications of science to the promotion of Arts, Maufactures, and Commerce.

The Royal Society and the British Association both deal with the advancement of pure science, while institutions such as that of the Civil Engineers occupy themselves with progress in the particular profession with which they are associated. A purely scientific society has equal interest—at least such is the notion—in every scientific truth or discovery, and is indifferent to its being of practical utility. For instance, it is assumed to be a matter of as much interest to the Royal Society that there have been discovered satellites attendant upon the planet Mars, as that there should be a discovery made which might be applied to the utilisation of the sun's rays for the obtaining of motive power, resulting in the saving of our store of coal.

The Society of Arts, however, does not feel this equal interest in all scientific discoveries; it is essentially a Society for the promotion of Arts, Manufactures, and Commerce, and therefore it is not until it finds a scientific discovery or principle applied to some useful purpose, or at all events until there is a reasonable prospect of such an application being made, that the Society of Arts becomes (as a society) concerned; but when scientific discoveries have been so applied, or when there is seen a reasonable probability that they will be, the Society of Arts at once feels the deepest interest in them; and therefore it is that I believe I shall not be inviting you to misuse your time this evening, when I ask you to join with me in reviewing some of the improvements that have taken place in recent years by the application of science to industry.

Naturally, an engineer (as I am), when the question of applied science comes before him, has his thoughts directed to that motor which to the present stands pre-eminent—the steam-engine. With respect to this motor, I do not know that I can say there has been made within the last few years an application of any new scientific principle or discovery; but, undoubtedly, there has been the further development of those principles upon which the economical action of the steam-engine depends.

We know that the wasteful steam-engine is one without condensation, without expansion, and one working at comparatively low pressure. We know, on the other hand, that the economical steam-engine is one with condensation, with expansion, and with high pressure; and further, we know that to enable great expansion to be really useful, in practice that expansion must be accompanied by the jacketting of the cylinders in which the expansion takes place.

There is, probably, hardly any subject more illustrative of the advantage of the application of science to industry than that of steam jacketting. The jacket, as its very name implies, is an envelope within which, but not quite filling it, the steam cylinder is placed, the space between the envelope and the cylinder being filled with steam. It might, or rather I should say it inevitably must, strike any one that this is a contrivance whereby, although the cylinder itself is kept hot, it can only be at an expenditure of a greater amount of steam by condensation in the jacket, than would have been condensed in the cylinder if the steam jacket were not used; because that jacket, having of necessity a larger surface than that of the cylinder, must condense more steam. We engineers are aware that such an opinion has been entertained, not merely by those unconnected with the profession, but by one of the earliest and ablest writers on the theory of the steam-engine. We now know, however, thanks to the thorough investigation the subject has received at the hands of scientific men, why it is that, notwithstanding by the use of the jacket, we do undoubtedly expose the steam to the action of a greater cooling surface than it would be exposed to were no jacket employed, the result of steam jacketting is a considerable economy, with expansive steam-engines, in the total quantity of steam used.

Sir William Armstrong, in his most admirable Presidential address to Section G of the British Association this year, at York, stated that in his view the further improvement of the steam-engine lay in the direction of higher pressure and higher expansion; and until some new, and at present wholly unexpected, application of science is made to the steam-engine, I think we must all agree that we know of no direction by the pursuit of which greater economy is to be attained other than that of which Sir William Armstrong spoke. Period by period, pressures have gradually increased in the last half century, from 3½ lbs. to 10 lbs.; from 10 to 15, from 15 to 30, from 30 to 60, and from 60 to 100, in stationary engines, and in those used for marine navigation.

With respect to this question of increased pressures, one engineer, a member of the Council of the Society of Arts—I allude to Mr. Loftus Perkins—has, in succession to his father and grandfather, devoted persistent attention to the employment of much greater pressures than any of those above mentioned, in order to efficiently work with a high expansion. Mr. Perkins has now had for many years engines running with steam of 400 lbs. pressure above atmosphere, with expansion of thirty-fold, with an excellent vacuum of from 27 to 28 inches, and with the resulting economy that might be expected of a consumption of only 1⅔ lbs. of coal per indicated horse-power per hour even in comparatively small engines.

Some present, who know that engines using only 100 lbs. steam are reported to work for 2½ lbs. of coal per horse-power per hour, may look upon the difference of ⅚ths of a pound, which alone exists between these two rates of 1½ lbs. and 1⅔ lbs., as practically unimportant, and such a feeling is, I think, by no means unreasonable. It is easy to appreciate the value of the reduction made when 7½ lbs. of coal per horse-power per hour consumption is brought down to 5 lbs., but it requires a little thought to enable one to perceive that a reduction from 2½ lbs. to 1⅔ lbs. is as large a per-centage as is the reduction from 7½ lbs. to 5 lbs.; but nevertheless it is so, and therefore the diminishing the consumption from 2½ lbs. to 1⅔ lbs. has the same effect upon the increase in the time during which a steam vessel can keep at steam without having to replenish her fuel as that due to a diminution from 7½ lbs. to 5 lbs.; from which it follows that where a steamboat, worked with the very great economy of 2½ lbs. of coal per gross indicated horse-power per hour, could keep the sea for only 14 days, one working with a consumption of 1⅔ lbs. could keep the sea for 21 days, a matter which is frequently of more importance than that of the mere saving in the cost of the coal itself. Again, it must be remembered that, in taking into consideration the cost of coal, that has not to be measured alone by the price paid for the fuel at the port where it is put on board, but also by the lost earnings of the freight displaced.

It will interest the members to know that Mr. Perkins has now very nearly completed one of his engines, wherein the initial pressure on the boiler is to be 1,000 lbs., and the expansion in the engine is to be 320 times. The mode adopted by Mr. Perkins for jacketting his cylinders is peculiar and extremely ingenious, and I trust that even with the high rate of expansion here proposed, the diagrams will shew there has been no unnecessary condensation of steam within the cylinders themselves. Further, I am sure the members will be glad to see by our programme that Mr. Perkins has promised to give the Society a paper upon this subject, sometime in the Session, after the engines have been put to work and tested.

Having studied the steam-engine, and having watched its development and improvement for upwards of half a century, it is with regret I am forced to come to the conclusion I recently expressed in a discussion before Section G at York, namely, that unless, as I have already said this evening, some wholly new, and at present even undreamt of scientific discovery, or application of science, be made to the steam-engine, it will have, I fear, to yield its place to other means of obtaining motive power from fuel. It must be remembered that the average of steam-engines in use throughout the United Kingdom certainly do not give forth 1-25th of the energy which may be taken as residing in the fuel they consume, and that if even the horse-power were obtained for as little as 1 lb. of coal per hour, such an engine would give forth but 1-6th to 1-5th the energetic value of the coal. Obviously, this is an unsatisfactory result, and it appears to me enough has already been done to render it probable that not only can better duty from the fuel be obtained, but that as regards safety, first cost, cost of maintenance, cost of attendance, saving of space, and weight, the advantage will be on the side of some motor that utilises the fuel without the intervention of steam. We are, however, perhaps, many years removed from the practical realisation of the full advantage which appears to be derivable from such steamless motors, and in the meantime we must look upon those who save our store of fuel, by increasing the economy of the steam-engine, as public benefactors.

It does not occur to me that we can point to any new applications within the last few years of science to the construction and ordinary working of railways, we must content ourselves, as in the case of the steam-engine, with general development. In the locomotive, dimensions, pressure, and power have increased. In the construction of railways, steel has been largely introduced in lieu of iron for the rails; in the working of railways, the block and interlocking systems have been extended; the facility for rolling stock to adapt itself to curves, by the employment of bogies or their equivalents, has been increased, thus diminishing wear and tear, and enabling the speed of the trains to be improved. There is good reason to believe that in the immediate future steel—now a cheaper material than iron made by the puddling process, and one of a very much more valuable character—will come into extensive use for sleepers, and will supersede the wooden sleepers, as the wooden sleeper superseded the stone block. Should this change take place, I believe I am right in saying that it would find as much work for steel-producing industries as is found for them by the use of the steel rails themselves.

In the construction of the railway, the introduction of steel and the thorough application of science in the design of the work, render possible such railway bridges as that decided on for the crossing of the Forth, where certain of the spans will be one-third of a mile each in length.

In the lighting of railway carriages great improvements have been made of late years by the employment of gas from coal or from oil, and stored either in collapsible reservoirs, or under pressure in chambers. Not only have the safety and the speed of railway travelling been improved by the employment of the block system and of interlocking, but the continuous brakes which have come into use within the last few years, while no doubt adding to the safety, have added still more to the rapidity, with which journeys involving frequent stoppages, like those on the metropolitan system for example, can be effected.

Reverting to railway signals, means are now being suggested by which the signalman in a block signal-box shall not be able to "take off" his signal without the permission of the signalman in the next box, and at junctions or at crossings where interlocking is used, the signals must agree with all the points and with all the other signals; but, unhappily, in some rare instances, although the indications afforded by the signal are correct, they are neglected by the driver, and at other times, owing to fog, they are not visible, and are very imperfectly indeed replaced by the fog signal. To remedy these defects, there are already arrangements whereby the signalman can cause the whistle of the engine to sound, and thus call the driver's attention by the ear as well as by the sight, but it has always seemed to me to be desirable that a signalman should have still more power than this over the movement of the train—the power, when he puts the signal to danger, of therewith setting an apparatus which would not only sound the whistle of the engine, but would turn off the steam and apply the continuous brakes. I am well aware of the objection that might be urged against this suggestion, namely, that the driver, relying on the apparatus, would cease to look out for the signals, or even for the safety of the train, feeling that the care of it was taken entirely out of his hands; but I think this objection might readily be met, and in the following manner. Let it still be the duty of the driver to watch the signals, and to obey them, and to do so before the engine came to the place where the apparatus worked by the signalman would be situated. If, however, the driver had failed, on seeing the signal, to pay attention to its directions, then the apparatus, worked by the signalman, would come into play, but an arrangement could be provided which, in that event, would, on inspection of the engine at the end of the journey, show whether, on any occasion during that journey, the stopping of the engine had been effected by the apparatus and not by the driver himself; and should it appear that the engine had not been stopped by the driver, he would, unless he could give a satisfactory explanation, become liable to fine for non-fulfilment of duty. I cannot help thinking that some such further development as this of the control of the trains by the signalman in the signal-box, is well worthy of consideration.

With respect to the large development of tramways that has taken place within the last few years, to the great convenience, it may be, of those who travel in tram-cars, but to the unbounded inconvenience of those who use ordinary horse carriages on the roads where trams are placed, there is not much to be said as to scientific application, beyond the domain of experiment, up to the present time; but so much attention has for the last few years been directed to the traction of tram-cars otherwise than by horses, that it is not too much, I think, to expect we shall shortly see horse traction superseded by the steam-engine, as now employed in Leeds; by compressed air, either on the Mekarski system as now, and for some time past, very successfully employed at Nantes; on the system of Colonel Beaumont, or on that of Mr. Scott Moncrieff, with both of which systems interesting trials have been made; or the traction may be effected hereafter by the use of gas, or by the employment of electricity, whether that developed by stored-up energy in batteries, or that obtained by means of connexion with some dynamo machine. In some one, or in all of these modes, it appears to me reasonable to hope that before many years have elapsed our horse traction will as, I have said, be superseded. But if this should be accomplished, how long would it be before persons desirous of having carriages upon ordinary roadways, and not upon trams laid down on these roadways, would feel that the mode of traction employed in the tram-car ought equally to be applicable, both mechanically and legally, to the moving of carriages not running on the tram. At present, the law imposes certain obligations before sanctioning the employment of any of these motors upon tram-cars, obligations in respect of which some modification might probably be advantageously made, but which are in themselves as a whole reasonable, having regard to the safety of the general public; but I do not see why the steam or air-moved tram-car, which is a vehicle traversing the ordinary roads and running on a special part of these roads should be under only certain restrictions quite compatible with its successful working, while other carriages which traverse upon the same roads, but are not confined to a line of rails, should have such restrictions imposed on them as to render their propulsion by mechanical means practically impossible. Were these restrictions modified, I think that we should very speedily see this question of the mechanical propulsion of common road carriages brought back to as good a condition as that in which it was left by Walter Hancock 40 years ago. Hancock, it may be remembered by some present, used at that time to run his steam omnibuses from Paddington to the Bank, and from the Bank to Stratford, among all the traffic of the streets, without the slightest danger or difficulty of any kind or description, and it is to be regretted that when he abandoned the subject it fell into the hands of ordinary mechanical engineers, who, when they did produce a steam carriage at all, produced one partaking of the rigid nature of a railway locomotive, and one rendered alarming by its noise, and by the exhibition of moving machinery.

It is certain that by the use of compressed air, or even of steam employed as Hancock employed it, it is possible to make mechanical tram-cars, or mechanical common road omnibuses, as inoffensive to sight and to hearing as are ordinary horse omnibuses; to make them, indeed, so that there should be no other objection from the horses' point of view than that attendant upon self-propulsion; that is to say, their appearance would be no more alarming than would be that presented by an ordinary tram-car, from which the horses had been removed, running by gravity down a gentle incline at the ordinary rate of travel.

In steam navigation we have had within the last few years many applications of science, and many improvements, as well in the form of the vessel, as in its construction, and in its propulsion. The Institution of Naval Architects has undoubtedly done much for the development of steam navigation, and among the members of that institution, to no one is more credit due than to their distinguished late associate, William Froude. It is to his laborious series of experiments upon large models, carried out and recorded by the aid of the most ingenious and scientifically-devised apparatus, and conducted under such conditions of speed in relation to size, as rendered the results obtained by the models thoroughly trustworthy guides to the behaviour of the full-sized vessel, that we owe the knowledge of the true resistance of the different forms of ships, and are enabled to determine what dimensions and shape should be used, having regard to the particular purpose and rate of speed for which the vessel is required. Guided by such knowledge as this, steam-ship owners are, year by year, venturing to make their ships larger and larger. A very recent instance indeed is that of the *City of Rome*, with a length of 586 feet, a breadth of 52¼ feet, a depth of hold of 37 feet, and a total depth of nearly 60 feet, and a displacement of 13,500 tons. On her very first voyage she carried, it will be remembered, the enormous population (for no other term can be employed) of 1,600 persons. Her propulsion is derived from three compound "tandem" engines, working a single screw.

When considering the rapid growth that, year by year, is taking place in the size of ocean steamers, the reflection that inevitably occurs to one is that about a quarter of a century ago the *Great Eastern* was put to sea, that she exceeds in her dimensions those of any ship built either before or since, and that she was commercially unsuccessful, while the tendency of the present day, in the view of maintaining commercial success, is to build vessels which are gradually coming up to her dimensions. It may be that the explanation of this anomaly is to be found in the fact that her engines, constructed as they were on designs now nearly 30 years old, are far less economical than the engines of the present time, and that thus the *Great Eastern* would have been an extremely expensive ship to work, especially at the rate of speed now demanded for passenger vessels.

I wish next to call your attention to one extremely beautiful result of the application of science to navigation, and that is the mode employed in H.M.S. *Inflexible*, for the purpose of checking rolling. It consists (as probably you are aware) of placing in a close-topped transverse tank extending across the width of the vessel some 70 tons of water, which occupy about only one-half the place in which it is confined—in other words, it consists in putting into a vessel that which has hitherto been deemed a thing to be scrupulously avoided, namely, shifting ballast. If there is one thing more than another which even a landsman would say ought not to be movable, it is ballast, as being movable it will roll to the low side of the ship, and by weighting that side down will tend to capsize the vessel; and there is no doubt that this objection holds good when a vessel is heeling over, to near the critical point, and when it is in doubt whether she is to come upright again or to capsize, but it is not at such times as these that the loose water-ballast of which I am speaking would be employed. Its use would be confined to those occasions when a vessel is not under press of canvas, occasions such as that, say of a steamer rolling, and would be employed with the object of preventing the oscillations from assuming a dangerous magnitude, as they might if the disturbing force happened to coincide in point of time with that of the rolling period of the vessel. The principle on which the loose water-ballast acts to check rolling, can be seen from a consideration of the measure employed to artificially roll a vessel for the purpose of experiment. When this is needed, men are directed to run up to the high side of the deck, in order to bring that side down, and then to move over to the opposite side when that in its turn has risen, in order to bring that opposite side down. By such means the roll of the ship is increased; obviously, if the body of men were employed to run down to the alternate low sides as the ship rolled, instead of running up to the alternate high sides, their weight thus applied would tend to diminish the rolling, and to bring the ship sooner to rest. This running down to the alternate low sides is precisely that which is done by the loose water-ballast; so soon as the vessel heels over to one side, the water-ballast goes to that side and impedes the rising, and when, notwithstanding the impediment, it has risen so as to heel in the opposite direction, the water-ballast shifts over again and makes the rising more slow, and in this way checks the rolling which had been set up. It may be said that the loose ballast is a dangerous implement to employ, for that on some occasions, when it is extremely undesirable to press the ship on the side which is already down, the loose ballast will be there, abusing its functions and doing harm. The answer to the objection is, that a provision is made for letting the water out of the transverse tank into the double bottom, where it is confined in compartments in that bottom, and from loose ballast becomes fixed ballast, tending to keep the vessel upright. The *Inflexible* has now gone on her trial cruise, and it will be interesting to receive the official reports of the value, in practice, of this most striking example of the application of purely scientific thought to an improvement in navigation.

During the last few years, navigation has also been benefited by Sir William Thomson's improvements in the compass, and by his ready means of sounding without stopping the way of the ship, but I must trust these means may be well known to many of you, as time does not admit of my entering into their description.

It would not be right to leave the subject of navigation without some allusion to the high-speed steam launch and the high-speed torpedo boat. These vessels—the initiation of which is undoubtedly due to Messrs. Thornycroft—have developed a speed which only a few years since would have been pronounced by the greatest authorities in naval matters to be simply unattainable in boats of so small a size; and there can be no doubt that these striking results are due to the application of science, as well to the determining the form of the hull, the selection and scantling of its materials, as to the determining the nature and the proportions of the engines. As a result, as much as 20 miles an hour or more of speed is got out of a vessel only some 80 feet long, while as I have said elsewhere, a gross indicated horse-power is obtained for as little as half a cwt. including the water in the boiler. It has been stated that if a gross indicated horse-power could be produced from an engine weighing only 40 lbs., it would be possible for a steam-engine of this lightness, if I may use such a term, to raise itself by means of revolving vanes from the ground and maintain its position in the air. Assuming this calculation to be correct, it is still obvious that until engines can be made much lighter even than the 40 lbs., no useful result could yet follow, as, if the weight of the engine were not reduced below the maximum permissible, there would be no power of carrying any store of fuel, still less the ability to carry any aeronaut; nevertheless, an engine capable of raising itself in the air would afford a very interesting experiment, and one well worthy the consideration of an amateur mechanical engineer.

In motors other than the steam-engine, attention should be called to the admirable results arising from the application of science to the gas-engine. Until the last few years, gas-engines made no progress; they produced very little work for the amount of gas consumed, and they were unsatisfactory in every way. As an instance I may mention, that at the Institution of Civil Engineers, when rebuilt in the year 1868, a gas-engine was fixed, for the purpose of working the fan which ventilates the meeting-room. Its use was continued for a few years until it had proved itself so thoroughly unsatisfactory that it was removed, and was replaced by a hydraulic engine.

In the gas-engine, the power is developed (as is well known) from the ignition of a combustible mixture of gas and air. In the early gas-engines, a sufficient and uniform charge of such a mixture was introduced into the cylinder, and being lighted either electrically or by the application of a gas flame, an explosion took place, attended by an immediate development of pressure and of heat. The piston being attached by the connecting rod to the crank could only travel at such pace as was permitted by the motion of the crank, and thus it was not possible for the piston to move with the needful rapidity to turn into work the heat developed by the explosion. This heat, therefore, was communicated to the walls of the cylinder, from which it was abstracted by a constant current of water, and thus a very great part of the energy was uselessly carried away. Moreover, the pressure upon the piston, instead of being that which is desirable, viz., a practically steady or continuous pressure, giving as it were a push to the piston, was short and violent, inflicting on the piston and its connection a blow. The subject being considered scientifically, these defects were brought to light, and the cause of the non-success of the gas-engine was ascertained. The first attempt at a remedy was the liberation of the piston from the crank shaft, so that upon the ignition of the mixture the piston could be shot upwards in the cylinder at a pace rapid enough to utilise a great portion of the heat, and to convert it into work. On the descent of the piston under atmospheric pressure, a rack attached to it became, by means of palls, connected to the wheel of the driving shaft, and thereby gave the necessary rotary motion. Engines of this construction were largely made, and afforded good economic results, but they were noisy, and were also irregular in their motion.

The recent improvement in gas-engines was, while re-establishing the connection between the piston and the crank, the providing for an immediate and useful absorption of the heat generated in the explosion. This is effected by charging the cylinder, not merely with the explosive mixture as before, but with that, *plus* a considerable quantity of any incombustible aëriform fluid of some kind, either atmospheric air, or the products of combustion, as the case may be. This incombustible part of the charge is situated in the cylinder, at a part remote from the point of ignition, and gradually mingles with the combustible mixture, which is richest at the point of ignition, and it is into the incombustible aëriform fluid, thus provided to receive it, the heat generated passes, thereby raising the pressure of the whole volume of aëriform fluid in the cylinder this pressure propels the piston, and the whole mixture being of considerable bulk, the pressure is sustained so as to follow up the piston as it moves away. An indicator diagram taken from one of these engines closely resembles that from a steam-engine, and differs widely from the short, sharp blow diagram of the early gas-engine.

The result of this improvement has been to cause the gas-engine to be introduced and employed in a vast number of cases. There are many temptations to the use of a good gas-engine. There is no fear of the boiler blowing up, no fear of its being injured for lack of water, no stoking is needed, hardly any attention is necessary; and having regard to the great requirement for electrical illumination in clubs, theatres, and even in private houses, there appears to be a very large future for this kind of motor.

Ordinarily, gas-engines are worked by the gas supplied from the public mains, but we are to be favoured here this Session by a paper from Mr. Dowson, describing the arrangement he uses for generating a cheap gas, not suited for illuminating purposes, but calculated for employment in motor engines. According to the statements made by Mr. Dowson, at York, it would appear that power can even now be attained by this mode of utilising fuel for less cost than it can be obtained in the ordinary steam-engine of the present day.

Perhaps it would hardly be right to bring within the elastic period of which I am thinking, namely, the last few years, the great development in steel manufacture made by the Bessemer process, and by the Siemens process, as these have now been before the public for some time. But very great improvements have been made in the processes themselves, tending to the greater uniformity of the product as regards its chemical constitution, and tending also to the soundness of the castings produced. With respect to this latter point, improvement is of two kinds; one, the mode of putting pressure upon the steel while fluid, so as thereby to diminish the area of the cavities, the other, the getting rid of the cavities themselves; and with respect to this operation, special attention should be called to the stirring apparatus now used for this purpose.

In steel manufacture we have another striking instance of the value of the application of science to industry, whereby is eliminated the foreign material to be found in Cleveland iron ore, which, while existing in the metal, renders it unfit for the production of steel. The process of Messrs. Thomas and Gilchrist appears to have satisfactorily accomplished this problem, and thereby promises to bring into use for steel manufacture large deposits of iron ore which otherwise would have been unfitted for that purpose. I am glad to say that a paper on this subject by the inventors is also among those which will be read in the course of the ensuing Session.

In my address to the Bristol Trade and Mining School, in 1877, I pointed out that although, while dealing with such a material as wood, there was no reason to suppose that chemistry would ever change pine into oak, or beech into mahogany, there was reason to believe that, when dealing with an elementary substance, such as iron, chemistry might succeed in getting rid of the extremely small proportion of foreign matter which, small though it might be, was sufficient, when combined with the iron, to lower its quality, and to render it unfit for the manufacture of the best iron and wholly unfit for the manufacture of steel, and I expressed my belief that the time was not far distant when, by the application of science to iron manufacture, this end would be attained, and thus large tracts of iron ore in England would be relieved from the stigma under which they lay of not being suited for the purpose of the manufacture of best iron and of steel. I am glad to feel that, in the four years that have elapsed since that, address, a great step has been made in the direction there indicated.

With respect to the application of chemical science, the public at large are more used to think of it in connexion with analysis or with separation than in connexion with building up of needed substances from their elements, but, nevertheless, chemical science is applied to synthesis. We have notable instances of this in the production artificially of indigo, and of the colouring matter of madder, and it is not, I trust, being too hopeful if we venture to look forward to the time when the application of chemical science shall succeed in building up artificially many other products which at present are only attainable from some organic substance.

One great field for the application of chemical science is that of the utilisation of waste products. The process of dealing with waste products is a curious one. It is very commonly as follows:—In the first instance there is established a manufacture, having for its object some particular product. So long as this product is sold at a good profit, the persons engaged in its manufacture have no desire to embark the capital necessary for dealing with matters which they look upon as mere by-products—or, more probably, as waste products, and thus they had formed into heaps of refuse, or are let to flow down the water-course to the nearest river, according to their nature, or else they are disseminated through the air. The next step, ordinarily, is that persons in the neighbourhood object to such disposals of the waste products, on the ground that they are sources of annoyance or even of positive injury. Then the High Court of Justice is applied to, an injunction is obtained or threatened, and the manufacturer is compelled to cast about for some means of disposing of them, not with a view of making profit out of his waste products, but simply of getting rid of them without annoyance to his neighbour. A very frequent result of this laudable effort is, however, that in so casting about it is found that that which had hitherto been nothing but a noxious nuisance, may not only be prevented from being so, but may be made into a source of profit.

We all remember when gas-works were voted nuisances because of their contaminating streams with their ammoniacal liquor, and we also know that they were at a loss to discover an outlet for the coal tar they produced. At the present day, thanks to the application of chemical science, the ammoniacal liquor is used in the manufacture of sulphate of ammonia, while coal tar is the material from which the chemist extracts colour, flavour, and perfume, and, indeed, so valuable are becoming the by-products of gas manufacture, that the time seems to be fast approaching when it will be doubtful whether these products should not be considered as the primary object of the manufacture, and the gas itself should be looked upon as the by-product. By another application of chemical science the material which has been used for the purification of the gas is made to render up, in a marketable form, the sulphur which it has extracted from the gas.

I have the authority of our Member of Council, Prof. Abel, for saying that among the most striking examples of the utilisation of waste products is that of glycerine. At first this material was, I believe, without any application whatever; then, thanks to Mr. Warren De La Rue, it was found of value for the prevention and cure of chapped hands; but now it is used in enormous quantities in the manufacture of our most valuable explosives; and on this subject let me remind you that the researches which Prof. Abel has carried on, in conjunction, in many cases, with Captain Andrew Noble, into the theory of explosives, have resulted not only in valuable improvements in artillery, but have been of the greatest service in the application of explosive agents to the industrial purposes of tunnelling, of mining, and of subaqueous engineering.

Let me give you an instance from another class of manufacture, that of pig-iron, which has given rise, as we all know, to unsightly mounds, encumbering the earth with great blocks of hard grey slag. Now, at the present day, thanks again to the application of science, the slag is being made into bricks, into paving material, into Portland cement, into glass, into slag wool, and even into a species of cloth (of which samples are on the table), for the purpose of clothing boilers and steam pipes.

I was told the other day of another very striking instance of the utilisation of waste products, and that is the production of brick, excellent both as regards its structure and its colour, from the waste of slate quarries, a material which, like the slag of the iron furnace, has hitherto been useless, and has disfigured the face of the country by its aggregation into mounds.

Thus far I have dealt with the cases of the nuisance caused by the liquid pollution from gas-works, the solid nuisance of slag heaps; and now with regard to the pollution of the atmosphere, I desire to be permitted to remind you that those chlorine vapours, which formerly escaped as noxious waste-products, blasting the country for miles around, are made into health-preserving chloride of lime.

In that matter which most immediately concerns every individual, and therefore every nation—the provision of food—within the last few years, refrigerating processes, carried on in accordance with the strictest teaching of physical science, as applied in the compression and expansion of air, have enabled meat to be transported from the Antipodes in quantity such as to yield, while selling at a low price here, a profit to those connected with the venture; while, with respect to corn, within the last few years the attention of scientific men has been turned to the constitution of the grain of wheat, and as the result we are discarding our old system of grinding, and are converting the wheat into sharps or middlings, from which the objectionable parts are removed, and the remainder, being crushed by rollers, instead of being ground by mill-stones, produces a quality of flour superior to anything that was ever known as the result of the old process of milling. Unhappily, we have, for several seasons in succession, been afflicted with bad harvests, either because the crop has been scanty, or has not matured, or because the crop, though good in itself, has been harvested in bad condition, owing to the prevalence of wet weather. It does seem to me that here there is an opening for useful application of science. The quantity of moisture contained in the grain of wheat is obviously not so considerable as to render it commercially impossible to employ artificial means of drying. I am well aware it has been said that kiln-dried wheat is objected to; but surely there must be a course between the drying given in an ordinary kiln and the slight kind of drying which would suffice to preserve the wheat from depreciation after it was stacked. I hope to see the time when we shall have a portable drying machine taken into the field, and the crop passed through it, and immediately passed through the threshing-machine.

Among the recent instances of the application of science to the preparation of food is that of the "creamer," which rapidly separates the cream from the milk. As we know by the old process many hours had to elapse to enable the cream, by its inferior specific gravity, to extract itself from the milk with which it was mixed, and to come to the surface, or probably the better description would be—to enable the milk by its superior gravity to fall to the bottom. It is obvious that, if the force of gravity could be made more powerful, the process of separation would be a more rapid one. One way to attain the same end as would be attained by an increase in the power of gravity, is to employ a revolving vessel, moving at such velocity that the tendency to flow off centrifugally shall be many times in excess of the force of gravity. If, under these circumstances, such a material as fresh drawn milk (containing both milk and cream) were put into the vessel, the heavier particles of milk will make their way more rapidly to the exterior of the vessel than they would fall by the mere act of gravity to the bottom of a pan, having a depth equal to that of the radius of the revolving vessel, leaving the cream in the axis of the vessel, which axis, when revolution is taking place, represents the upper surface of a quiescent vessel. As a matter of fact, by this apparatus the separation of the cream from the milk is effected in the course of a few minutes, and thus both the milk and the cream are delivered perfectly fresh, and without the slightest dairy taint.

I think I had better anticipate here, that which otherwise would have come among the observations I have to make on the applications of electrical science, by reminding you that Dr. Siemens has applied electricity to promote the growth of flowers, fruit, and vegetables, and even of grain. I do not pretend to say that the matter has gone further at present than the state of experiment, but it has been experimented on a very considerable scale, and it appears to me to be quite within the bounds of reasonable expectation that those, at all events, who devote themselves to forcing fruit for the London markets will ere long find the electric light become as much a part of their needful apparatus as are the hot pipes themselves with which they keep up the temperature of their houses.

Further, while on the subject of food, let me say that at the Paris Exhibition there was to be seen an application of electricity to a purpose I have already mentioned to you, viz., the purifying of the middlings by separating from them the objectionable particles which need removal before the middlings are fit to be pressed into semolina.

We have all heard of how unadvisable it is to kill the goose that lays the golden eggs, but there are cases where the goose must be killed. You may want to have goose-flesh to eat, or, as has been most parodoxically said, you may need to kill your goose to save its life; but whatever may be the reason for death, it is desirable that any unlaid golden eggs which may be discovered in the interior of the goose should be rescued and made available, and this, science enables industry to do, in the case of the killing of the animal that produces, not golden eggs, but milk, and therefrom the cream and the golden butter. When one of these animals is killed, large deposits of fat are found, which I believe the physiologists would tell may be regarded as material in store for milk production, in fact an unlaid golden egg. Science has taught us how to extract from the fat—not milk, nor cream—but something closely resembling butter itself. To this material the name of "oleomargarine" is given by its friends, and "bosh," I am told, by its enemies. But leaving to friends and to enemies the task of settling upon a name, I may say that the process of extraction is an extremely interesting, and also a most cleanly one, and the product appears to me to be as free from any objection as would be the butter itself that is made from cream in the usual way; but, nevertheless, I prefer less scientific butter.

Among the subjects which have excited public attention during the last year there is that of smoke abatement. No doubt, as towns increase in the manner in which London has increased, the smoke question becomes more and more important. In London there are four millions of persons occupying an area which, if I take as my standard that presided over by the Metropolitan Board, is 117 square miles in extent, involving, therefore, even if the 117 miles were in the form of a regular circle, a diameter of 12½ miles, or a radius of 6¼ miles. Under these conditions, one sees how extremely difficult it is for the inhabitant of the centre of such an area to have the clear atmosphere of the country. Whichever way the wind blows, he must receive the products of combustion going on in 6¼ miles of a more or less densely-populated district, and probably those of certain manufactures. I am inclined to think, however, that as regards manufactures, the Smoke Act in London works so well that a very little of the nuisance arising from smoke is due to the chimneys of manufactories.

It must be within the knowledge of all who hear me, that if you stand on one of the bridges, and look along the Thames, chimney after chimney will be seen from which not a trace of smoke is passing out. I do not mean to say that there are no infringements of the Act, but I believe that when they occur they are promptly repressed, and that, as a result, the combustion of coal used for engine fires is, in London, in a very satisfactory condition.

As is the case with most subjects on which the popular mind is exercised, there is a very great deal written and said about smoke and its abatement, which would not be put forward if those who understood the subject were alone to write upon it. Now, it is a common observation in smoke articles, that if a manufacturer emits smoke from his engine chimney, he must be losing a large quantity of fuel in an unconsumed condition, and that therefore he is not only annoying his neighbour, but is at the same time injuring himself. The fact, however, is that the weight of the solid particles of the smoke is almost inappreciable as compared with the weight of the fuel burnt—only a portion of one per cent. The means employed to prevent smoke from engine-boiler fires are, it may be said, almost universally a very free admission of air above the fuel. In this manner, if there be heat enough in the furnace, it is easy to ensure the combustion of smoke, but it is by no means certain that this combustion will not be effected at the risk of passing through the fire and through the flues, a far greater weight of air than that really needed to properly consume the combustible materials, and that in this way a loss of heat may readily occur, greater than that which would arise from the sending a few pounds per ton of coal burnt, of unconsumed particles of carbon into the air, in the form of smoke. If these facts were always present to the speakers and writers on the smoke question, we should not have such repetitions of the statement of the folly, in a pecuniary point of view, of those who do not voluntarily burn their smoke.

With respect to domestic fires, there is very little doubt that close stoves properly constructed are far more likely to consume the smoke of domestic fires than are the open fire-grates. There is equally no doubt that very much less fuel is needed to heat an apartment when a close stove is used, than is needed when an open fire-place is used. But it should always be remembered that where there is an open fire-place there is of necessity ventilation, and in a room where there is not an open fire-place, unless great care is taken, there is not adequate ventilation; and even when, in the absence of fire-places, provisions are made for proper ventilation, it is almost impossible to ensure that these provisions shall not be thrown out of use by those who have the control of them. With respect to ventilation, it is the thing that the natural man abhors. In reference to it, I feel inclined to paraphrase that which has been said about charity, namely, that it is an emotion of the mind, in which A never sees B in want, without desiring to relieve him, not with the goods of A, but with the goods of C. Similarly, it may be said that when A feels the atmosphere of a room stuffy, he desires it to be changed, not at the risk of himself, A, catching cold, but at the risk of B, or any person other than A. If a proof of this were wanted, let me refer you to any assembly where there is some big man whose orders are taken, a judge on the bench, or a chairman of a meeting. What is the direction to the attendant, when the judge or chairman feels there is a need of ventilation?—"I feel the air of this court or room very close, open two of those windows down there,"—"down there;" not—"open two of the windows near me." The big man, with the natural fear of ventilation, lets somebody else bear the burden, while he himself gets the benefit. It is very rarely, indeed, that the man "down there" has either the readiness or the courage to protest. The only instance that occurs to me of the kind, is that of Sydney Smith, when, as a curate, sitting at a dinner largely attended by the higher orders of the clergy, he said to the waiter, who was about to open a window close by, "don't give me my death of cold; open one behind a Bishop."

If this repugnance to ventilation be true, as it is in the case of the educated, the well-fed, and the well-clothed, we must not wonder at finding it prevail among the poorer classes, sparingly fed, and insufficiently clothed. Give the poor man an open fire-place and he must have as much ventilation as will allow the smoke to go up the chimney. I look upon our open fire-places, wasteful as they are of coal and productive as they are of smoke, as great sanitary agents in dwellings, especially of the poorer classes; and I will appeal to anyone who has had experience of the atmosphere of Continental rooms in the winter time, when the windows are closed and a close stove is employed, as to whether such an atmosphere is not far worse than that which prevails in rooms where open fire-grates are used; and I think I may, without fear of the nature of the answer, ask whether, on the whole, the appearance of the inhabitants of London, smoky as their atmosphere may be, does not compare favourably with that of those who live in cities with a far clearer atmosphere, but occupy rooms where, owing to the use of close stoves, there is no efficient ventilation.

These considerations alone should make us pause before we determine, for the sake of clearing the atmosphere, on giving up open fire-places, and on resorting to stoves having good combustion. But there is another consideration in the same direction, which I think should not be lost sight of, and that is, the cheerfulness and companionship of an open fire—advantages which, I think, few Englishmen would willingly resign. Nevertheless, if those who turn their attention to the subject will bear in mind this fundamental question of proper ventilation, and take care that it is not tampered with, all of us would rejoice to see an improvement in the clearness of the London atmosphere. We know that our distinguished Member of Council, Dr. Siemens, has applied his powerful mind to the subject, and as the result, proposes that we should employ the two products of the gas-works—coke and gas; so that, while at the works the gas and coke have been divorced, in the house they should be re-united, to produce a cheerful, smokeless, managable fire in an open grate.

Besides Dr. Siemens's plan, there are the numerous and very successful gas-fires, many of them of a cheerful appearance, and certainly extremely clean in their use and easy to manage; but so far as my experience goes, this last class of fires must be looked upon as an expensive luxury.

Let us hope that real science will be applied to this subject. I may remind the meeting of two stoves which existed, not within recent years, but long before recent years; one, wherein the grate was upon an axis, so that upon coal being filled upon the top, the whole apparatus could be turned upside down, thus putting the raw coal at the bottom. Another, Cutler's stove, wherein the fire is lighted at the top, and the grate has a rising bottom, gradually bringing up the fuel. I remember this latter principle of fire being used in a boiler furnace at the Royal Dockyard, Woolwich, I should think upwards of 30 years ago. In this instance, it was employed under a waggon-boiler, where there was plenty of space. Of course, such a plan would be difficult of application in those cases where boilers are internally fired, but, as I have stated, I do not think it is in the consumption of coal for industrial purposes that the bulk of the London smoke is made.

I have said that the question of abating smoke has lately much occupied the public attention, but there is no doubt that the subject connected with the application of science, which during the last year or two has most fully impressed the public mind, is that of electrical development.

For many years past, the public have been familiar with the telegraph, both in its common English form of the double and single-needle instrument, giving visible, but unrecorded indications of the message; in the form of the Morse instrument, whether used to record marks on a slip of paper, or to communicate by the sound; or in the more complex form of the printing telegraph, delivering its information in ordinary printers' letters; and of late years the latter system of telegraph has been applied to transmit to various offices in the City the nature of the transactions on the Stock Exchange directly they are made, thereby giving an undoubted record of the variations of prices from time to time, and, by an extension of the system, news is transmitted now, from moment to moment, to clubs and to other similar establishments.

The public also are aware, and the Society of Arts particularly are aware, thanks to the lectures delivered by our Member of Council, Mr. Preece, of the wondrous extension of the power of communication by telegraph, given by the duplex, and still further by the quadruplex systems.

Recently, however, as we all know, the application of electrical science for the purposes of communication has resulted in the telephone, the instrument by which one is enabled to transmit articulate speech, or rather one is able at the one end of the connecting wire to reproduce in an instrument the speech which at the other end, and in the other instrument, has caused variations in an electrical current. After a considerable delay, arising from various causes which I will not go into, London is at last waking up to the advantages of the telephonic communication.

A statement has recently been made which shows that, irrespective of private telephones, there were transmitted, during October and November, the daily average of 9,750 telephone conversations in London; and when we remember that these conversations are, in most cases at all events, question and answer, and frequently several questions and several answers, it is indeed too little to say that these 9,750 conversations may be regarded as equal to, at least, 19,500 telegraphic messages; and further, it should be considered, the probability is the conversations exceeded more than the number of words in an ordinary telegraphic message and answer. Not only have those who are in correspondence by telephone all the advantages over telegraphy which conversation possess over writing, but they have these coupled with the following advantages:—There is not the trouble to the sender of writing out his message, of taking it to the office, of buying the stamp, of being compelled personally to stick the stamp upon the message; neither is there the risk of the writing not being properly deciphered, of the risk that when properly deciphered it is not properly transmitted, and the further risk that the receiver of the message does not properly understand it, or if he does, fails to write it out properly. Lastly, there are saved to the officials the labour of writing out the message, and the labour of sending it to the person for whom it is intended. The whole of these expenses, annoyances, and sources of error are obviated by the use of the telephone. It is not surprising, therefore, to find that these 9,750 conversations have cost the subscribers to the telephone who sent them only $2\frac{18}{100}$ pence per conversation, or $1\frac{8}{100}$ pence per lengthy message. And it must be remembered that, as fresh subscribers accrue to the Telephone Company, each subscriber will make a greater use of his instrument, and thus the cost of each conversation will be diminished.

I believe I am right in saying that the Telephone Company, who are only allowed, under decision of the Law Courts, to exist by the grace of the Post-office, are restricted in their operations by it to the use of wires not exceeding for each wire five miles in length, a restriction which, we must hope, will soon disappear.

You have all of you read of the wondrous effect produced in telephonic transmissions arising from the use of double transmitters and double receivers. At the Opera at Paris, two transmitters, placed at opposite sides of the stage, are connected to two telephones applied at once to the two ears, and thereby doing for the organ of hearing that which the stereoscope does for the organ of sight. I was assured, when in the neighbourhood of Liverpool recently, that for more than a year an unhappy invalid, not able to leave her room, had been in telephonic communication with the parish church, to her great comfort. Thus it will be seen that, whether having regard to business, to amusement, or to piety, the telephone is too useful to be hampered in its development. One result of that development will no doubt be to multiply the cobweb of over-head wires, which now assists the smoke of London in obscuring the sun. Let us trust that it may be found commercially practicable to put all these wires under ground, and that should it be so found, proper powers may be given to the Telephone Company to enable it thus to place them.

It would not be right to leave this branch of my subject, the conveyance of intelligence by electricity, without some notice of writing telegraphs. Under this head I include that of Mr. Edison, wherein the message or design is written, or drawn, with a hard pencil on ordinary paper. This paper is wrapped round a cylinder, and by a combination of the revolutions of that cylinder, with end-way traverse, the whole surface of the paper is passed under a movable style, which is actuated by the variation that exists between the surface of the plain part of the paper and that of the part on which is the writing. The movements of the style break and make contact, and at the receiving end this "break and make," aided by traverses in the two directions, similar to, and synchronous with, those of the apparatus at the transmitting end, mark on a prepared paper a *fac-simile* of the message or of the design.

A few years since, Mr. E. A. Cowper, the President of the Institution of Mechanical Engineers, invented that which is, in the truest sense, a writing telegraph; one wherein there was no need that the message should be in the first instance inscribed on a piece of paper. The sending operator had merely to write upon a strip of travelling paper, the only use of which, however, was for the keeping of a record, as the mere going through the performance at the sending end of appearing to write would suffice to cause that appearance to be reproduced on a diminished scale as actual writing at the receiving end of the telegraph. Mr. Cowper's apparatus, it should be said, required two line wires.

If it would not be right to leave this branch of my subject without some mention of writing telegraphs, still less should I be excused if I passed away from it without reminding you of that most ingenious instrument, the photophone, by Prof. Graham Bell, whereby sounds, and even speech, are caused to suitably modify from moment to moment the intensity of light directed upon the receiving instrument, which, by this modification, is made to deliver articulate speech. Thus a ray of light is substituted for the ordinary telegraphic wire. This invention is rendered possible by the employment of that peculiar element, selenium, which, in 1873, Mr. Willoughby Smith discovered had powers of conducting electricity, varying with, and dependent upon, the strength of the light which fell upon it. Further, I must call your attention to the development of this invention referred to in a paper read by Mr. Perry before the Society, last Session, and also to another development described by Mr. Shelford Bidwell in his paper read at the Royal Institution in March last.

We all know how equally of late years electrical science has been applied to lighting purposes. It is now upwards of twenty years since the Dungeness lighthouse was first illuminated by electricity, and those who remember the Exhibition of 1862 must have in their minds the electric lighthouse apparatus then exhibited; but notwithstanding this early exhibition and use of the electric light, it for a long time made but little advance, and it is hardly too much to say that the last four or five years have seen a greater progress in electric lighting than had been previously made in all the years that had elapsed from the time of its first introduction. In addition to the arc light, the only mode of electric lighting practised in former years, there is now largely employed, especially for domestic and semi-domestic purposes, the incandescent lamp, and you are aware that by its aid theatres, picture galleries, private houses, steamboats—the *City of Rome*, for example—are now most satisfactorily illuminated, that is to say, the light is steady, is mild, is diffused, does not appreciably heat, and does not at all vitiate the atmosphere in which it is exhibited. Moreover, the incandescent light is free from those violet and somewhat spectral tones which occasionally prevail where the arc light is employed. I am sure it is your wish I should take the opportunity of publicly repeating our thanks to Mr. D'Oyly Carte for his kindness in allowing the members of the Society to inspect, last Saturday afternoon, the arrangements for electrically lighting the Savoy Theatre.

Electrical science has also turned its attention to the practical question of the transmission of energy from sources thereof, to places where it is desired that energy should be exercised for some useful purpose. Last year we had a very valuable paper from Mr. Alexander Siemens on this subject, especially in connexion with the transmission of energy, for working railroads and tramways. I may mention, in passing, that at the present moment a tramway, to be worked by the power given forth by a waterfall, is being constructed in the north of Ireland, under the direction of our Member of Council, Dr. Siemens. All of you who have had the good fortune to see the exhibition at Paris, must have witnessed the satisfactory way in which the electrical tram-car of Dr. Werner Siemens, running between the Exhibition and the Place de la Concorde, fulfils its functions.

Further, there has been devoted, lately, a great deal of scientific thought to that which is inaccurately called the "storage" of electricity in secondary batteries. I am not about to quarrel with the term, for it is a convenient one, but it may perhaps be as well to say to a general audience that in these secondary batteries electricity is not stored as *electricity*, in the manner in which it is stored in a Leyden jar, but that the battery is put—by the action of an electric current on it—into such a condition chemically, as to enable it to give forth the energy residing in it readily, in the form of electricity, when required so to do. It will be premature to express an opinion as to the part such storages may play hereafter. Even at present, however, one can see a use for them in the guarding against irregularities in the action of motors producing electricity; and also in providing a supply of electrical energy during the time that the motor might from any cause be out of operation. I desire, however, not to be understood as saying that we may not look forward to the time when, by storage means, energy may be made portable, as it were, so that an electric tram-car may be driven without a wire connexion, with a motor (as, indeed, has already been done), and so that agricultural machinery—reaping and mowing machines—may carry with them their own motive power.

I have already mentioned, when speaking of the application of science to the production and to the preparation of food of the use made by Dr. Siemens of electricity to ripen fruits and even grain, and of the use of electricity to separate out the noxious portions of the middlings preparatory to their being submitted to rollers to make them into semolina flour, and I will bring the remarks on this, the electrical part of my address, to an end by reminding you of the experiments that have been made by Dr. Siemens in the application of electricity to the melting of metals, experiments which have shown how it is possible by the aid of electricity not only to utilise the power residing in a fall of water to light up a house, but to utilise it also for the purpose of melting iron and steel, for boiling water, or for cooking the dinner.

Examples of these various applications of electrical science to industrial purposes, and many other examples that time does not permit me to touch upon, are brought together in that most admirable electrical exhibition in Paris, which is just about to close, an exhibition which, to the scientific man and to the intelligent follower of industrial pursuits is pregnant with lessons of the highest importance, and must have afforded even to those who have not made electricity their study, a deep gratification. I do not dwell further upon that which was to be seen there because time does not permit, and because, as regard the greater part of the leading subject embraced within it, I have already made more extended observations than are warranted, having regard to the due length of an address.

Passing to a totally different subject, let me say that no record, however brief and imperfect, of the benefits derived, within the last few years, from the application of science to industry could pass over without notice, those which the silk industry and the wine industry owe to the laborious investigation of Mons. Pasteur and others into the nature of the silkworm disease, and the means for its prevention; and to his investigations into the true nature of ferments. Further, let me recall to your recollection that most admirable paper, reproduced *in extenso* in the *Times* of August 9th, read by Mons. Pasteur before the Medical Congress assembled in London this year, in which is stated, with as much lucidity as modesty, the share he has taken in the researches that have been made into the causes of splenic fever in sheep, and into those of a certain disease in poultry, and the results of his investigations, whereby he had been enabled to guard the sheep and the fowl against the ravages of disease, disease which, in the case of the sheep, appeared occasionally to be communicated to human beings. It is not too much to say that in the instance of Pasteur, the application of science has already been attended with the most beneficial results to great industries, and with the saving of animals from premature death and from suffering, and, attendant upon this, the saving of food; and it is, I trust, not too much to hope that the continuance of these investigations may have in the future a practical and important bearing on the prevention of disease among human beings. I am happy to say that this subject will be fully brought before you during the Session, in a paper by Dr. Thudichum.

Leaving improvements in manufactures, let me say a few words on a subject closely connected with that commerce in which our Society feels so warm an interest. For its protection are needed ships of war armed with cannon, machine guns, and torpedoes, and protected by plating.

Within the last few years there has been a continuous development of the application of science to the improvement, both of the means of defence and offence with which these protecting ships are furnished. With respect to offence, cannon have increased from 12 tons to 38, from 38 to 80, from 80 to 100. There is now fired from a 100-ton guns shot containing more metal than was employed to make a short 24 pounder gun a respectable cannon in the days of Nelson. The construction of such guns would have been impossible had not science lent its aid to show how the material should be disposed, so as to enable the whole of it to come at once to the resistance of the pressure produced by the combustion of the powder within the gun; and even when the artillery itself had been rendered so much more capable of resisting internal strain by reason of this scientific mode of construction, the pressures produced by the needed large charges for guns of such size as those of which I have been speaking—as much as 550 lbs. of powder being burnt in one charge—would have been too great to be withstood, had not the character of the powder been changed from the comparatively small grains used a few years ago to the prismatic powder of the present day, wherein 17 grains (so-called) weigh as much as 10 lbs. In fact, science applied to artillery has had a similar result to that of the application of science to the gas-engine—it has changed the short intense pressure of an explosion of small grain powder to the lower but longer continued pressure produced by the ignition of prismatic powder. And this has been done, attended not only with no loss in the power of the projectile, but absolutely with a large increase, the muzzle velocities of the same weight of shot having risen from 1,300 or 1,400 feet per second up to over 2,000, giving an increase of energy in the shot of two to one. There have been made, and are now being made, guns wherein the deposition of the material in the most advantageous manner is being arrived at by the enveloping of the barrel of the gun with successive layers of steel wire, or steel riband. Steel in this form having been prepared by the draw-bench is, even when of a somewhat soft character so as to obtain high ductility, still of great strength, double that of the wrought-iron formerly employed. It is in a convenient shape for being applied to the guns, and being wound on cold, it is possible to ensure an absolutely regulated tension, all risk of weakness, such as might arise from imperfect welding under the old system of manufacture in any one part is done away with, and the plan appears, I think, to bid fair to come into general use.

In speaking on this subject, it is only common justice to say that the system of strengthening gun-barrels by coiling wire about them, was patented as long ago as the year 1855, by Mr. Longridge, M.Inst.C.E., who brought the subject before the Institution of Civil Engineers in the year 1860, in a paper entitled "The Construction of Artillery and other Vessels to resist great internal pressure."

Further, with respect to offensive material, we have the torpedo and the machine-gun, but time will not admit of any detailed allusion to these, nor will it enable me to do more than remind you, in respect of the defensive side of the question, that the strength of armour has been most materially increased by the manufacture of composite plates, formed of about one-fourth of their thickness of steel (on the face side), welded to the remaining three-fourths of their thickness of wrought iron.

I think it most unlikely there should be any here to-night, forming part of a meeting of the Society of Arts, who would have come into this room with any doubt as to whether it is for the good of the community that science should be applied to industry. That some persons entertaining such views are still to be found is, I fear, true, but I do not expect them to be present at a meeting of the Society of Arts. Were any such persons here, however, I think I might safely appeal to them as to whether the instances that I have given of the improvements which have been made within the last few years, by such application of science, have not, to some extent at all events, converted them. One thing is quite certain, that, although they may deny the value of the application of science to industry, they day by day enjoy—it may be unwittingly—the various advantages that flow from these applications; and I think I cannot do better than remind you of the test that has been proposed on more than one occasion as applicable to those who regard with preference the state of things which existed but a few short years ago, and ask them to consider whether, if railways, steamboats, gas-lighting, the telegraph, and even the humble lucifer match, were suddenly taken from them, and they were relegated to the stage coach, the sailing packet, the oil lamp, the 8d. postage, travelling at ten miles an hour, and the flint, and steel, and tinder, when they wanted to obtain a light, their happiness would be increased. We all know that the honest answer would be, "No; not increased, but diminished." If it be thus true, as undoubtedly it is, that the comfort and welfare of all have been, within the last half century, materially increased by the developments of industry due to the applications of science, each development, when first mooted, being looked upon as absurd and chimerical, be it remembered, why are we to say that finality in improvement has been attained, and that it is not desirable that those who come afterwards should have there lot as much improved as ours has been in relation to those who have gone before us. The majority of those here will agree, that the preceding improvements have been attained by the application of science, and that the improvements that are to come will be thus derived. I am glad to say that this is the opinion of the majority of thinking men in England, who have studied the subject, and that there has been for the last few years a growing feeling that the power of making applications of science to industry should not be confined to a few scientific men, but that the knowledge and the training requisite for the further development of such application, should be extended to all those who are engaged in the direction, at least, of industrial pursuits. The teaching which gives this kind of knowledge we compendiously call Technical Education. I feel a difficulty in approaching the question, because I am aware my interest in it is so great that I am liable to trespass beyond the fair limits that should be assigned to it in this opening address. Let me remind you, however, that within the last few years the City and Guilds of London Institute, of whose Executive Committee I am Chairman, has been founded; that that Institute has now for some three years past being doing useful work in teaching; that it is now building its Central Institution at South Kensington, upon land given by her Majesty's Commissioners of 1851, whose President, and our President, the Prince of Wales, is also, I am glad to say, the President of the City and Guilds of London Institute, and that by taking up and following up with its larger funds the Technological Examinations established by the Society of Arts, it is not too much to say that the influence of the City and Guilds of London Institute is being felt over the whole country.

You will remember that a Royal Commission was appointed some short time back to visit the Continent, with the object of seeing into that which was being done there in Technical Education; and that among the members of that Commission is Mr. Magnus, the director and secretary of the City and Guilds of London Institute. I do not propose that we should servilely copy any body or any system, but I do propose that we should examine into all that has been done, and using the best of our judgment, should take so much of that which we find is good from any quarter, no matter where it may be, as appears to be suited to the character of the industries, and to the habits of thought and disposition of the people of the United Kingdom. I do trust that that which has been commenced by the City and Guilds of London Institute will, in the course of a few years, spread throughout the kingdom, and will in this way make good the arrears which, undoubtedly, have been suffered to accumulate. Let me remind you that neither in science nor in its application is there finality; that, unlike the study of a language, where a man may say that he understands all that there is to be taught, no one engaged in the pursuit of science and its application can ever dream of being anything but a learner, and therefore it is that with a groundwork properly laid by scientific teaching, and by the teaching in the application of science obtainable in youth, there will throughout life be needed constant application if a man desires to keep himself at the level of that which is going on, still more if he desire to be ahead of it. Let me say I think we may claim for the Society of Arts the position of being this needed continual technical educator, by reason of its papers, its lectures, and the communications in its *Journal*, and by reason of the various matters which it initiates from time to time, but having brought to perfection, leaves for other bodies to pursue.

One danger there is, however, in the spread of Technical Education, and that is, the danger of engendering conceit. It may be that a youth who has been taught in a science school, and then has been technically taught, will fancy that he knows all that is to be learnt in respect to the industry by which he hopes to gain his livelihood, and will look down with contempt upon those who have not had his advantages. To one who may feel inclined so to act, I should like to offer, for his benefit, the observations with which a report of John Playfair, Professor of Mathematics at Edinburgh College in 1801, concluded. There had been referred to Prof. Playfair, Telford's proposition for a single arched bridge in lieu of old London Bridge over the Thames. Prof. Playfair had examined it as a mathematician, or "Geometer," as he called himself, but having done so, he winds up his report with one of the most modest and unassuming statements that ever was made, which I will now read to you:—

"I cannot, however, make an end of this report without observing to the committee that it is not from theoretical men that the most valuable information, in such a case as the present, is to be expected. When a mechanical combination becomes in a certain degree complicated, it baffles the efforts of the geometer, and refuses to submit even to his most improved methods of investigation. This holds particularly of bridges where the principles of mechanics, aided by all the resources of the higher geometry, have not yet gone further than to determine the equilibrium of a set of smooth wedges, acting on one another by pressure only, and in such circumstances as, except in a philosophical experiment, can hardly ever be realised. It is, therefore, from men bred in the school of daily practice and experience, and who, to a knowledge of general principles, have added from the habits of their profession a certain *feeling* of the justness or insufficiency of any mechanical contrivances that the soundest opinion on a matter of this kind is to be obtained."

I have now brought to a close not only the citing of certain instances of improvement in various instances of improvement in various industries by the application of science, but also, somewhat abruptly, the few observations to which I have limited myself, as respects the advantages to be derived by the nation from the spread of Technical Education, being warned by the hour at which we have arrived that the address itself must be speedily ended; I will therefore only ask you to bear with me for a minute or two more, while I say a few words on a subject (the Patent-law) which is as important an agent in the development of industry as is Technical Education itself.

The practice of all civilised nations of any importance has concurred in the provision of a Patent-law, as being the best means by which invention can be protected, and as being the only means by which invention can be developed.

The existing Patent-law of England, practically that of 1852, although by no means deserving of the censure that has been heaped upon it, is, no doubt, unsatisfactory in many points. Last year, I stated in my address, that it was desirable a Bill should be prepared for the amendment of the Patent-law, in framing which it should be borne in mind that the interests of the inventor and of the public are identical, not in opposition. You all know that such a Bill as I then suggested has been prepared by the Society of Arts. It has been provisionally adopted by the Council, pending a discussion to be held upon it, which will take place here, not on Wednesday, the 30th Nov., as originally announced in the circulars, because that evening would conflict with the anniversary meeting of the Royal Society, but at a special meeting to be held on Friday, the 2nd December. This being so, I will not now enter any further into the question of the Patent Bill prepared by the Society, except to say that I think it does, in its provisions, cure the various defects that pertain to the present law, and that I hope that in any respect wherein the best course has not been followed, we shall, as the result of the discussion to be held in these rooms, and as the result of discussion already held at York, at the meeting of the British Association, be enabled to select that course and to produce a Bill which we may confidently urge should be adopted as a Government measure. Those of you who have perused the Bill will see that one of the leading features is to dissociate the Patent-law from lawyers; and I am glad to say that thus far, at all events, the present Government appears to agree with the Society, inasmuch as it has announced that the new Patent Bill will be prepared, not by the Lord Chancellor, nor by the law officers, but by the Board of Trade.

In conclusion, allow me to thank you most sincerely for the patience with which you have borne with this far too lengthy address.

Lord Alfred Churchill, in proposing a vote of thanks to the Chairman for his eloquent address, said that it was impossible to allude to the large field of subjects which had been treated of, and he would therefore only express the feelings of high appreciation which he was sure all those who had listened with deep interest to the address must entertain.

Professor Abel said that it hardly seemed necessary to second the vote of thanks, for the way in which the address had been received was sufficiently expressive of the feeling of the meeting, and he wished it was possible for them to see Sir Frederick Bramwell in that seat for some years to give a series of such addresses.

The resolution was carried unanimously.

The Chairman then presented the following medals and prizes:—

The Society's Silver Medal, for Papers read during the past Session:—

To Professor Alexander Graham Bell, for his paper on "The Photophone."

To E. Price Edwards, for his paper on "Signalling by means of Sound."

To Alexander Siemens, for his paper on "The Electrical Railway, and the Transmission of Power by Electricity."

To Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., for his paper on "Forest Conservancy in India."

To J. M. Maclean, for his paper on the "Results of British Rule in India."

To Sir Henry Bartle Edward Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., for his paper on "The Industrial Products of South Africa."

To J. Y. Buchanan, F.R.S.E., F.C.S., for his paper on "Deep Sea Investigation, and Apparatus used in it."

To Professor John Perry, for his paper on "The Future Development of Electrical Appliances."

The following Medals and Certificates awarded to the Designers and Workmen engaged in the productions of Furniture, &c., shown in the recent Exhibition of Art Furniture held at the Royal Albert Hall:—

THE SOCIETY'S SILVER MEDAL

To Mr. **R. Gleeson**, for carved fan mounts.

To Mr. **W. de Morgan**, for lustre plates.

To Mr. **Northwood**, for glass cutting and engraving (Mr. Pargeter).

To Mons. **Solon**, for olive green tea service, *pâte sur pâte* (Messrs. Minton).

To Mr. **Webb**, modeller and designer (Messrs. Collinson and Lock).

THE SOCIETY'S BRONZE MEDALS

To Mr. **William Allwright**, for design of rosewood chimney-piece, inlaid with ivory, ebony, Mother-o'-pearl (Messrs Jackson and Graham).

To Mr. **Baldwin**, for cabinet-maker's work (Messrs. Jackson and Graham).

To Mr. **Vernon Barnard**, for design of side of room (Messrs. Morant, Boyd, and Blanford).

To Mr. **W. P. Collins**, for designs for furniture (Messrs. Gregory and Co.).

To Mr. **T. Hinton**, for cabinet-maker's work (Messrs. Wright and Mansfield).

To Mr. **T. Jacob**, for marquetry top to table.

To Mr. **G. Price**, for beaten oxydised silver frame (Messrs. Collinson and Lock).

To Mr. **W. F. Randall**, for furniture designs and design for fender (Messrs. Howard and Co.).

To Mr. **Albert Reich**, for marquetry work (Messrs. Jackson and Graham).

To Mr. **Charles Reich**, for marquetry work (Mr. T. Jacob).

To Mr. **H. Reich**, for marquetry work of cabinet (Messrs. Morant, Boyd, and Blanford).

To Mr. **Victor Reich**, for marquetry work (Messrs. Wright and Mansfield).

To Mr. **H. Scholz**, for painted furniture (Messrs. J. G. Crace and Son).

To Mr. **Singer**, for beaten brass-work (Messrs. Collinson and Lock).

CERTIFICATES.

To Mr. **M. Anderson**, for carved work of vestibule seat (Messrs. Gillows).

To Mr. **S. Bryne**, for cabinet-maker's work (Messrs. Wright and Mansfield).

To Mr. **W. C. Codman**, for design of panelling (Messrs. Johnstone Jeanes and Co.).

To Mr. **T. W. Hay**, for design of woven silken fabric for room decoration (Messrs. Gregory and Co.).

To Mr. **C. Humphreys**, for cabinet-maker's work (Messrs. Wright and Mansfield).

To Mr. **Marchant**, for cabinet-maker's work (Messrs. Jackson and Graham).

To Mr. **T. Miller**, for cabinet-maker' work (Messrs. Wright and Mansfield).

To Mr. **W. Perry**, for carving in wood.

To Mr. **Charles Phelps**, for wrought-iron work.

To Mr. **Sidney Phelps**, for wrought-iron work.

To Miss **Eleanor Rowe**, for carved wood pilaster.

To Mr. **Edward Sears**, for painted tiles.

To Mr. **G. Tinworth**, designer and modeller of flattened round bowl, shown by Messrs. Doulton.

To Mr. **G. Tinworth**, for terra-cotta panels.

Miscellaneous.

LOCAL GOVERNMENT OF JAPAN.

The ancient government of Japan was an Imperial absolutism, the whole power of the government being vested in the throne; and the land and the personal services of the people were the Emperor's. The occupancy of the soil and the right of tillage were granted to all males, females, minors, and slaves at low rate, and the personal service exacted was confined to males, and was one day in twelve for adults, and one in twenty-four for minors. The military usurpation of the Shoguns gradually undermined this system, and established a feudal despotism. When these usurpations had been completed, the whole power and privileges of society were in the hands of two hundred and sixty chiefs, and less than half a million of their retainers, men at arms. They held all the offices of Government, both civil and military; they monopolised the whole of the land, and exacted heavy tribute from every trade and occupation. Consul-General Van Buren states that the revolution of 1868 swept away feudalism, and its powers were relegated to the Emperor, who established a bureaucratic centralism in its stead, which exercised all the powers of the general and local Governments; though the people gained no political power from the change, they were relieved from a class system, and procured the right to own the soil they tilled, and enjoyed incomparably greater civil rights. This was the new Government up to 1878. In July of that year an Imperial decree was issued, establishing local elective assemblies over the whole Empire. The country had been divided into thirty-six "ken" and three "fu," which latter were different only in name. These districts were subdivided into "ku" (villages), and "gun" (suburban divisions). Each of these different divisions and subdivisions has its assembly. These bodies have no real legislative functions, but a supervising power over the estimates and expenditures of the local Governments in their various districts. The assemblies of the "ken" or State are generally elected for a term of four years, one-half of the members being elected every two years. The qualifications for membership are first, male, 21 years of age, a resident of the "ken," and a taxpayer to the amount of 10 yen a year. The following are ineligible—lepers, convicted traitors, convicted felons (until after four years of good behaviour), bankrupts, priests, and Government officials, and those who have served for one term until the expiration of another term. The qualifications for electors are the same as for members, except that the requirement as to the amount of land tax is 5 yen instead of 10 yen per year. All elections are by ballot, the times and places of election being appointed by the governor of the "ken," and 15 days' public notice must be given; the ballot must bear the name and residence of the voter. A majority vote elects, but when two candidates receive the same number of votes, the elder has the preference; if of the same age, the choice between them is decided by lot. Votes can be cast by proxy. If the person elected declines the office, the one receiving the next highest number of votes is taken. The regular sittings of these assemblies are 30 days each year, but extra sessions can be held under the call of the chairman. There is no pay or travelling expenses or other emoluments attached to the office of membership of these assemblies, but clerical offices are paid. The duties of these assemblies are to receive the estimates for current expenses from the governor, and to thoroughly examine and deliberate upon them in the interests of their constituents, changing, modifying, striking out, or inserting items of revenue or expenditure. If any items are excessive, they have authority to reduce them, and if inadequate, to add to them. If any needed improvements are not included, they may insert them. The estimates thus amended are returned to the governor. Part of their duties is to provide the necessary revenue by proposing a tax bill, which is to be sent to the governor for his consideration. In case of disagreement between these respective bodies and the governor, the matter must be decided by the great council at Tokio. The matter thus under local control are the expenses of the police, construction and repairs of roads and bridges, hospitals and sanitary institutions, all educational matters, construction and repairs of dikes and embankments, reservoirs, and irrigating ditches, and the construction and repair of public buildings. There is no power in the local authorities to prorogue or interfere with these assemblies. The "ku" and "gun" assemblies are intermediate between the "ken," or provincial assemblies, and the people. The qualifications of the members and electors are the same as above described. They represent directly the people of their districts, and are supposed to know intimately the wishes and needs of their constituents. All proposed taxes and estimates go to them from the "ken" assemblies, and are considered and approved, or amended by them. They apportion the taxation of their districts and superintend the collections. They receive all petitions, verbal or written, and reject or approve, and forward them to the "ken" assemblies. They are the immediate friends, advisers, and mouthpieces of the people. This is the first system of elective representation instituted in the Empire, and these are the first representative bodies with any real power which have had any existence in Japan. Consul Van Buren says, "the system has many faults, it is somewhat complicated and cumbersome; the ballot is defective in that it is not secret, and therefore liable to be influenced; the voting by proxy is objectionable as tending to centre the power in the hands of a few; the qualifications for membership and for electors are much too restrictive; its whole tendency is to give the control of local affairs to the landholders, and to build up a landed aristocracy. The making members ineligible for consecutive terms is questionable, as depriving the people of the experience of their representatives. With all these defects, however, the creation of the system is a new era, not only in the political history of Japan, but it is unparalleled in the history of any Asiatic people."

VENEER CUTTING IN AMERICA.

An account has lately been given of the process by which large sheets of thin shavings of wood are obtained, which is here quoted from the *Gardener's Chronicle.*

These gigantic shavings were used in America for covering the walls of rooms, and they were affixed by a method very similar to that used for affixing paper. The process by which they are obtained is described as follows:—The logs are delivered to the mill-yard in any suitable lengths as may be required by the order in hand; those being cut when the operation was inspected were 4 feet long. After cutting, the logs are placed in a large steam-box, 15 feet wide by 22 inches long and 6 feet high, built separate from the main building. This box is divided into two compartments. When one is filled entirely full the doors are closed, and the steam, supplied by the engine in the main building, is turned on—the logs remaining in this box from three to four hours, when they are ready for use. This steaming not only removes the bark, but moistens and softens the entire log. From the steam-box the log goes to the veneer lathe. It is here raised and grasped at each end by the lathe centres and firmly held in position, begins slowly to revolve. Every turn brings it in contact with the knife, which is gauged to a required thickness. As the log revolves the inequalities of its surface of course first comes in contact with the keen-edged knife, and disappear in the shape of waste veneer, which is passed to the engine-room to be used as fuel. Soon, however, the unevenness of the log disappears, and the now perfect veneer comes from beneath the knife in a continuous sheet, and is received and passed on to the cutting-table. This continues until the log is reduced to about a 7-inch core, which is useless for the purpose. The veneer as it comes rolling off the log presents all the diversity of colours, and the beautiful grain and rich marking that have perhaps for centuries been growing to perfection in the silent depths of the great forest. From the lathe the veneer is passed to the cutting-table, where it is cut in length or width as desired. It is then conveyed to the second storey, where it is placed in large dry rooms, air-tight, except as the air reaches them through the proper channels. The pieces are here places in crates, each piece separate, and standing on edge. The hot air is then turned on. This comes from the sheet-iron furnace attached to the boiler in the engine-room below, and is conveyed through large pipes, regulated by dampers for putting on or taking off heat. There is also a blower attached, which keeps the hot air in the dry rooms in constant motion, the air, as it cools, passing off through an escape-pipe in the roof, while the freshly-heated air takes its place from below. These rooms are also provided with a network of hot-air pipes near the floor. The temperature is kept at 165 degrees, and so rapid is the drying process, that in the space of four hours, the green log from the steam-box is shaved, cut, dried, packed, and ready for shipment. After leaving the dry room, the veneers are assorted, counted, and put up in packages of 100 each, and tied with cords like lath, when it is ready for shipment. Bird's-eye maple veneer is much more valuable, and requires more care than almost any other, and this is packed in cases, instead of being tied in bundles. The principal timbers used are curled and bird's-eye maple, beech, birch, cherry, ash, and oak.

CHROME, MANGANESE, AND SULPHUR IN TURKEY.

The United States Consul-General Heap, reports from Constantinople that chrome is found principally in the Boroussa district of Turkey, where there are three or four mines, only one of which, however, is now being worked. It is a place called Dag-Ardi. This mine is leased at an annual rental of 35,000 dollars, and the lessee has the right to extract all the ore he can. From the mine the ore is conveyed by camels to Ghemlek, on the Sea of Marmora, whence it is shipped principally to Liverpool and Glasgow. The chrome obtained at Dag-Ardi is very rich, but, owing to the opening of other mines in Turkey and other countries, the demand has declined in England, and the output at Dag-Ardi has diminished. The yield is now very irregular, but the annual exports average 3,000 tons worth from 15 to 17 dollars per ton. The present value of the ore at Ghemlek is about 15·50 dollars per ton.

Within the last three or four years, ore of a less rich description than that just mentioned has been mined in the hills of Catarina and Leontarochorion, near Salonica, during which period about 3,000 tons have been shipped, the price of which was about 10·50 dollars per ton, delivered at the place of landing on that coast. Chrome is also found at Deorikieni, in the district of Castamouni, and at Aiyandan, near Sinope; but the attempts to mine it at these two places have been abandoned. Wherever it has been found, its cost has been largely increased by the great difficulty experienced in conveying it to a suitable place of shipment. The lack of proper mining machinery, and the difficulties created by the Turkish officials, have aided largely in limiting the yield.

Manganese is mined at Aptal, in the province of Trebizond, but hitherto the working of it has been grievously obstructed by the restrictions and demands of the Government representatives. The quantity exported has barely reached 700 tons yearly, the value of which is about 14,000 dollars. Two other mines in the same district have been disclosed. Manganese is also found at about nine miles from Flatza, on the Asiatic coast of the Black Sea, but is not mined. In Western Europe it is used in glazing earthenware, in colouring enamel, and in bleaching.

Sulphur ore, said to be plentiful and pure, is found in the small island of Anurgo, near Rhodes, but no serious attempt bas been made to extract and export it.

Correspondence.

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BOILERS OF KITCHENERS.

After the number of deaths caused by the explosion of kitchen boilers last winter, your correspondent, "F. B. W.," not unnaturally asks, in the Society's *Journal* of last week, whether some one can "suggest a remedy, and enable every householder to avail himself of such suggestion, and to sleep peacefully in his bed without the fear of being suddenly blown out of it some frosty morning." But before speaking of a remedy against explosion, we should like to say a few words about household boilers generally.

The old-fashioned cast-iron boilers with movable lids are of course free from the danger of an explosion. It is when the kitchen boiler is closed, and in connexion by pipes with an open cistern in the bathroom, that danger has to be guarded against. In this case, the boiler is made of wrought iron, as it has always to withstand a constant hydrostatic pressure of from 20 to 25 feet per square inch, but when from frost or furring up, the connexion between the boiler and the cistern is cut off, this pressure will steadily increase (owing to the generation of steam) until the limit of resistance of the boiler is reached, when it will burst, and unfortunately the stronger it has been made, the more serious will be the explosion.

It is an astonishing fact that there is rarely any provision made for relieving household boilers of any extraordinary stress, and they are consequently, in frosty weather, more dangerous than ordinary high pressure factory boilers, which are always fitted with at least one safety valve.

For our comfort and convenience, we utilise natural laws at our very hearths, in many cases regardless of the fact, that should these natural laws be thwarted by frost or the slow deposit of lime in the circulating pipes, we are preparing for ourselves a steam gun that may at any moment cause our destruction. The public naturally ask—Why are kitchen boilers not always supplied with a safety valve? The reason is, that the relief valves of steam generators 'lift' several times every day, and besides they are in connexion with the steam space, and not with the water of the boiler, thus being away from all calcarious deposit; but when a safety valve is attached to a household boiler, years might elapse before it was called upon to lift, and probably, at the critical moment, it would be set fast.

We have lately invented a safety tap for kitchen boilers (an illustration of which appeared in *Engineering* of 26th August last). In appearance it resembles a common tap, and is arranged to open and shut with a handle as usual; but when the pressure in the boiler exceeds the hydrostatic pressure due to the column of water, by four or five pounds, the tap is self-opening, and discharges the water and steam, thus preventing an accumulation of pressure that would otherwise burst the boiler; as the tap would be in daily use it could never become "set," thus overcoming the objection raised against ordinary safety valves.

Should any of your members like to see these safety taps, we shall be most happy to show them to them if they will call at our office.

FIELD, FIELD, AND COTTON.

22, Buckingham-street, Adelphi.

General Notes.

SMOKE ABATEMENT EXHIBITION.—At the meeting of the committee held last week, at 44, Berners-street, it was announced that the Society of Arts had resolved to add to the other prizes a special medal, to be given in the name of their Society, and that Lord Alfred Churchill was nominated to act with the Committee. Prof. Chandler Roberts reported that he had arranged for chemically testing the products of combustion during the course of trials of grates and stoves. Several interesting exhibits had come in during the week, and it was reported by the honorary secretary (Mr. Wm. R. E. Coles) that the arrangements for completing the exhibition were being pushed on as fast as practicable, that the applications for space were in excess of the amount at present available, and that fresh room would, if possible, be made for certain exhibits of special interest, which were still seeking admission. It was agreed that arrangements should be made with the School of Cookery for illustrating, by lectures and practical demonstrations, the use of some of the exhibits. Among the exhibits received during the past few days, some from France, Germany, and America were mentioned. Lectures by Prof. Chandler Roberts and Capt. Galton were arranged for, to be given during the exhibition, and lectures by others were being arranged.

CANADIAN CATTLE TRADE.—The annual report of Mr. Pope, the Minister of Agriculture for the Dominion of Canada, for the year 1880, gives an account of the growth of the Canadian cattle trade with Great Britain, which appears to have assumed larger proportions in 1880 than in any previous year. The increase in exported cattle alone was 100 per cent. in the year, the total numbers for 1879 and 1880 being as follows:—1879—cattle, 25,009; sheep, 80,332. 1880—cattle, 59,905; sheep, 81,843. This increase, of a continuance of which there is every prospect, is due in a great measure to the healthfulness of Canadian stock, and to the very full and complete watchfulness exercised at the cattle quarantines, which protect it from many diseases that other countries suffer from. The duty of Canadian farmers themselves in the matter is pointed out by Mr. Pope, who writes:—"I cannot too thoroughly impress upon all Canadian feeders and shippers of cattle the great importance of shipping none but first-class animals. Much has already been done to improve the breed of cattle, but there still remains much to be done in this direction. To obtain the breed best adapted for feeding, with a view to making Canadian beef occupy the best place in the English market, rests with the Canadian farmer. All in the trade should ship none but the best cattle." The effect of this new trade on Canadian farming itself, so far as the older provinces are concerned, in the direct benefits which the partially worn-out and exhausted soils derive from the feeding of a larger head of cattle before shipment, is also pointed out.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 21....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "Some of the Industrial Uses of the Calcium Compounds. (Lecture I.)
British Architects, 9, Conduit-street, W., 8 p.m.
Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. Opening Address of the Session, by Sir John Smale, late Chief Justice of Hong Kong.

TUESDAY, Nov. 22....Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8.30 p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Henry Joseph Butter, "Forces and Strains of Recoil in the Elastic Field-Gun Carriage."
Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Dr. E. B. Tylor, "Notes on the Asiatic Relations of Polynesian Culture." 2. Rev. R. H. Codrington, "Notes on the Affinity of the Melanesian, Malay, and Polynesian Languages." 3. Rev. Lorimer Fison, "Fijian Riddles." 4. Dr. J. Beddoe, "On the Stature of the Inhabitants of Hungary."
Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., at 8 p.m. Mr. Robert G. Webster, "England's Colonial Granaries."

WEDNESDAY, Nov. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Sylvanus Thompson "The Storage of Electricity."

THURSDAY, Nov. 24...Royal, Burlington-house, W., 4.30 p.m.
Antiquaries, Burlington-house, W., 8.30 p.m.

FRIDAY, Nov. 25...Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. W. H. Gilburt, "On the Structure and Division of the Vegetable Cell."
Clinical, 53, Berners-street, W., 8.30 p.m.

SATURDAY, Nov. 26...Physical Science Schools, South Kensington, S.W., 3 p.m.

Journal of the Society of Arts.

No. 1,514. Vol. XXX.

FRIDAY, NOVEMBER 25, 1881.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

On Monday evening last (21st inst.) the first lecture of the First Course was delivered by Mr. Thomas Bolas, F.C.S., the subject being "Some of the Industrial Uses of the Calcium Compounds." Mr. Bolas alluded to the distribution and occurrence of calcium in nature, and the abundant existence of carbonate of lime as limestone, chalk, marble, calcspar, shells, &c. He referred to the new metallurgy of Davy as initiated by the isolation of potassium; and pointed out the probability that some of those metals which are abundant, but not in general use, may soon come into notable importance. In conclusion, some of the most important points in the general chemistry of the calcium compounds were demonstrated. The isolation of the metal calcium by the electrolytic decomposition of its fused chloride was shown experimentally, the necessary electric current being furnished by a machine constructed on Pacinotti's principle, and driven by a small gas motor.

PATENT LAW DISCUSSION.

The Discussion on the Society of Arts' Patent Bill will not be held on Wednesday, November 30th, as previously announced, but on Friday, December 2nd. The discussion will be opened by Sir Frederick Bramwell, F.R.S, Chairman of the Council, and will be continued on such evenings as may be found convenient. Non-members should apply to the Secretary for tickets of admission.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the the Indian Section was held on Wednesday, the 23rd instant, at 4.30 p.m. Present:—Mr. Andrew Cassels (in the chair), Sir George Birdwood, Mr. Hyde Clarke, Lord Alfred S. Churchill, Sir William Rose Robinson, K.C.S.I., Mr. J. T. Wood, with Mr. Trueman Wood, Secretary, and Colonel Hardy, Secretary of the Section. The programme of papers to be read during the present session was discussed and decided upon.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

In connexion with the course of Cantor Lectures, which will be delivered by Captain Abney, F.R.S., on "Recent Advances in Photography," in January and February next, it is proposed to hold, in the House of the Society of Arts, an Exhibition of Photographic Appliances.

The dates of Captain Abney's Lectures are January 30th, February 6th, 13th, and 20th. The Exhibition will be kept open from January 30th till about the end of February.

The Exhibition will be of a technical character, and it is not, therefore, desired to collect photographs of artistic merit only.

The following are among the principal classes of objects sought for exhibition:—

Apparatus: cameras, lenses, tents, instantaneous shutters, slides, sensitometers, lamps (intended specially for photographic purposes), enlarging apparatus, printing and mounting apparatus, &c.

Photographic materials.

Illustrations of new processes; negatives and prints produced by new or special processes.

Appliances used in reproductive processes; specimens of illustrations produced by such processes; specimens of historical interest, as illustrations of old processes.

Lighting: models illustrative of characteristic features in the construction of glass houses; methods of fixing glass without putty or similar material; arrangements for the production of artificial light for photographic purposes.

Any person wishing to exhibit any of the above is requested to communicate with the Secretary of the Society, who will supply printed forms of application for space, and will be glad to give any further information required.

It is hoped that arrangements may be made for showing the actual working of some of the more recent processes.

Proceedings of the Society.

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SECOND ORDINARY MEETING.

Wednesday, 23rd of November, 1881; Prof. W. G. ADAMS, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barlow, William Henry, F.R.S., M.I.C.E., 2, Old Palace-yard, S.W.
Bryden, Frank J., 2, Bulstrode-street, Welbeck-street, W.
Ekman, Carl D., 57½, Old Broad-street, E.C.
Gregory, Bertrand, F.C.S., Claremont-park, Blackpool.
Habershon, Samuel Osborne, M.D., 70, Brook-street, Grosvenor-square, W.
Hardingham, George Gatton Melhuish, A.M.I.C.E., Oriel Lawn, East Moulsey, and 191, Fleet-street, E.C.
Lowood, John Grayson, The Brooms, Glossop-road, Sheffield.
Miley, John, 14, Hilgrave-road, South Hampstead, N.W.
Montgomery, Archibald, Bush-house, Isleworth.
Owen, Charles Thompson, 19, Compton-street, Chesterfield.
Paterson, Edward J., 76, Little Britain, E.C.
Pearson, Henry William, A.M.I.C.E., 17, Alexandra-road, Clifton, Bristol.
Thornhill, Lieut.-General Anthony Robert, Lavender Farm, Bracknell, Berks.
Tinney, W. Upton, A.M.I.C.E., Staple Garden, Winchester.
Turnbull, George, 2, Collingham-place, South Kensington, S.W.
Ure, The Hon. John (Lord Provost of Glasgow), Cairndhu, Helmsburgh.
Wills, W. M., 57, King William-street, E.C.

The Paper read was—

THE STORAGE OF ELECTRICITY.

By SYLVANUS P. THOMPSON, B.A., D.Sc.,
Professor of Experimental Physics in University College, Bristol.

INTRODUCTORY.

Science has of late made two advances, the ultimate importance of which it would be difficult to over-estimate. Not many months before he was seized with the mortal illness which robbed us too soon of his rare and unique genius, Professor Clerk Maxwell was asked by a distinguished living man of science what was the greatest scientific discovery of the last 25 years. His reply was: "That the Gramme machine is reversible." His far-reaching and philosophic mind had perceived that in this phenomenon, which to so many had seemed little more than a curious scientific experiment, lay the principle which, if rightly developed, would render possible the electric transmission of power, and, in the solution of this practical problem, bring about social and economic changes, the importance of which but few of us have even yet begun to realise.

If we could to-night summon up the noble spirit of the philosopher, and ask him to tell us what recent scientific discovery came next in importance to this, I think we should receive the reply "that a voltaic battery is reversible." The reversibility in the action of the voltaic cell is the counterpart and complement of the reversibility of the Gramme machine; for while the one has solved for us the problem of the *electric transmission of power*, the other has solved for us the problem of the *electric storage of energy*.

The storage of energy in such a form, that it shall be available for producing electric currents, and for the electric transmission of power, is a fact of so great importance, both in science and in commerce, that no apology is needed for bringing the subject before the Society of Arts. But the electric storage of energy, which is the end attained, must not be mistaken for the storage of that subtle agent, electricity itself. A century ago, it was thought that the Leyden jar provided a means of bottling-up electricity itself. In one sense this may be true, though the fact remains, that the more carefully we hunt for the charge of electricity condensed in the jar, the more difficult does it become to realise that there is anything there; and it is doubly difficult to find, in the electric *accumulator* or *storage cell*, anything which can be called stored electricity. In electric accumulators, such as those of Planté and of Faure, electric currents are made to do a certain kind of work, which store of work can again yield us currents of electricity. But as a matter of fact, the particular kind of work done is, as we shall see, quite as much chemical as electrical. Just as in Sir William Armstrong's hydraulic accumulators, water forced into a vessel with a great pressure furnishes a means of storing mechanical power under such conditions that when we let it down it can do work for us, so in the electric accumulator, by which we want to store electric currents, we use a chemical storage, and the chemical work so stored can itself, as it runs down, set up electric currents in our wires, and do electrical work for us.

Before dealing with the various systems of electric storage that have been suggested, I purpose to lay down two important general principles. They are as follows:—

Firstly, that no kind of storage of energy, mechanical or electrical, is possible, except by doing work in overcoming some force which itself opposes the process.

Secondly, that the action in which work is thus done, must be one that is reversible; that is to say, to which there is an equal and opposite reaction.

ELECTRICAL ACTION AND REACTION.

"To every action there is an equal and contrary reaction." In these words Newton laid down the great fundamental principle of mechanical science. Its application is not limited to such mechanical reactions as the recoil of a gun, the return of a bent spring, or the mutual attractions of the planets, but reaches down into other departments of science. To Newton himself, we owe the simple experiment in which he proved the extension of the principle to magnetic forces. He found the magnet to be drawn towards a piece of iron with a force precisely equal to that with which it drew the iron to itself. It was left to Newton's great contemporary, Robert Boyle, to demonstrate that the same law held good also for the force of electric attractions; an electrified body drawing a non-electrified one towards itself, and being itself attracted with an equal and oppositely directed force.

But Newton himself showed that there existed another and deeper meaning to the law of action and reaction, when he laid down the famous comment[*] which, though forgotten until unearthed by Sir William Thomson, virtually anticipated the nineteenth century discovery of the theory of the conservation of energy. As understood in the light of modern dynamics, any "action" in which energy is spent and work done is found to have its corresponding "reaction" in the possibility of the energy thus stored being at some later time set free. That particular "action" of an agent to which Newton told us there was still an equal "reaction," when the action was measured by the product of its momentum into its velocity, was, in fact, nothing other than its *capacity for doing work*.

If you lift a pound of iron to a certain height against the pull of gravitation, the action implies the expenditure of a certain amount of energy, the equivalent of the work done. Precisely an equal amount of work (saving a trifling proportion converted into unuseful work of another kind, namely heat) can the mass of iron do in falling back again: for by its fall it may do the work of raising another pound to the same height.

In the science of electricity and in magnetism the same fundamental principle holds good. Suppose, for example, energy to be spent in the following action. Let a heavy weight descend over a pulley, and in its descent cause the disc of a Holtz's electric machine to rotate; the work done in this case is electric work, the energy being expended not in moving matter against gravitation or any similar force, but in moving electricity against those electric forces which are continually urging it to run down to the dead level of equal and uniform potential. But our supply of electricity thus provided can itself be made to do work, because it can thus run down and give out in another form the energy expended on it. Only let it be led by wires into the terminal poles of another Holtz machine, and it will drive it round, and by driving it round may be made to lift a weight. The reaction here is the converse of the action, and would be equal but for inevitable waste by friction and dissipation of the electric charges.

Another instance of electric action and reaction is afforded by the reversibility of dynamo-electric machines, such as that of Gramme, as mentioned at the outset. The Gramme machine can be used either as a generator or as a motor. If driven by the power of a steam-engine, or a gas-engine, or by wind-power, or water-power, or hand-power—in short, by any mechanical means whatever—it generates powerful currents of electricity, which may be used for producing electric lights, or any other kind of work that an electric current can do; the currents of electricity being due to the rapid movements of coils of wire fixed upon a rotating armature across a field of magnetic force, excited by the currents themselves in the machine. If, on the other hand, currents furnished by any suitable source are led by wires into the coils of a Gramme machine, these currents will drive it round, and will expend their energy in producing mechanical rotation, enabling the machine to be used as a motor.

Here I may remark, in passing, that the reversibility of the Gramme machine affords a means of electric, or rather of electro-mechanical storage. Suppose we want to store electric currents. Set them to drive a Gramme machine, and let the Gramme machine, by means of a pulley, gradually wind up a very heavy weight. If, subsequently, we let the weight descend, it will drive the Gramme machine, and will generate currents as it runs down.

ACTION AND REACTION IN VOLTAIC CELLS.

We now pass to the more immediately important case of the reversibility of the voltaic cell, and of its chemical and electrical actions.

In the ordinary voltaic cells, currents of electricity are produced at the expense of a certain consumption of zinc and of acid. These materials may be regarded as the fuels of electric currents, just as coke and coal are the fuels of steam power. Like those fuels, they represent a store of energy. Everybody knows that when two bodies attract one another (as for instance the earth attracting a stone), and we do work in separating them, they possess the power of rushing together again, and of doing work; and, therefore, when so separated, may be said to represent a store of potential energy. This is equally true in the case where we do work against the atomic attractions known as chemical affinity. Zinc has a certain chemical affinity for oxygen. To separate an atom of zinc from one of oxygen, requires energy to be expended. When thus separated they have the chance of doing work in reuniting, this work generally appearing in the form of heat. When a piece of coal is burned, that is to say, is permitted to unite chemically with oxygen, its store of energy runs down, and manifests itself in the evolution of heat. A piece of coal represents a store of energy. So does a bag of hydrogen gas. So does a piece of zinc; for zinc can burn directly and give out heat; or may burn indirectly by being dissolved in sulphuric acid, also giving out heat. A Daniell's battery represents a store of energy. A pinch of gunpowder also represents a store of energy. The amounts differ, it is true; and the rate at which some of these stores can be made available for use, also differs widely in the different cases.

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[*] "Si æstimetur agentis actio ex ejus vi et velocitate conjunctim," &c. Principia philosophiæ naturalis. This famous scholium is paraphrased as follows by Thomson and Tait ("Treatise on Nat. Phil." Chap. II., Art. 269):—"Work done on any system of bodies has its equivalent in work done against friction, molecular forces, or gravity, if there be no acceleration; but, if there be acceleration, part of the work is expended in overcoming the resistance to acceleration, and the kinetic energy developed is equivalent to the work so spent."

An ounce of coal represents an amount of energy which, if entirely expended in doing work, would raise 695,000 pounds one foot high against the force of gravity, or would do 695,000 foot-pounds of work. In an ounce of gunpowder is stored about 10,000 foot-pounds of energy. An ounce of zinc represents a store of only 113,000 foot-pounds. An ounce of copper represents a store of about 69,000 foot-pounds only. An ounce of hydrogen gas will yield, by combining with oxygen, 2,925,000 foot-pounds of work. Joule first showed us how to make use of facts like these, in calculating by its mechanical value the electric power of voltaic cells. Let us apply these considerations to the storage of energy in any ordinary voltaic cell—say, for example, the Daniell's cell used in telegraphy. In this cell we have certain liquids containing zinc and copper, chemically dissolved in sulphuric acid, and into these liquids dip a plate of zinc and a plate of copper. The zinc plate slowly dissolves away, and at the same time, metallic copper is gradually separated out of the solution, there being about $1\frac{1}{20}$ ounce of zinc consumed for every ounce of copper deposited. Now, to separate an ounce of copper from its solution in sulphuric acid, requires 69,000 foot-pounds of energy to be spent upon it; and as $1\frac{1}{20}$ ounce of zinc represents a storage of 118,650 foot-pounds, the consumption of this weight of zinc is enough to provide the 69,000 foot-pounds needed to separate the copper, and to leave a surplus of 49,650 foot-pounds. It is this surplus which goes to maintain electric currents in the circuit, and to do electric work.

But, as we have remarked, the voltaic cell is reversible. If we take such a cell, and by means of some superior electromotive force drive electric currents back through the cell, the whole action will be reversed. Copper will be dissolved, and zinc will be deposited. The copper in dissolving will help the process by giving part of the necessary energy, and our currents will thus once more give us back pure zinc, and so separating out the zinc we do work and actually store energy.

In modern treatises on heat, frequent reference is made to an ideal and wholly impossible sort of engine known as Carnot's reversible engine, which is supposed to have the power of being worked backwards, not however in the engineer's sense of reversing the motion, but in a much more striking sense. Carnot's engine, like every other engine, is supposed to act by heat passing through it from a boiler to a condenser, part of the heat so passing through being converted into work, and the ideal reversibility consists in the suggestion that if the engine could be driven backwards by spending mechanical power upon it, the work should be converted back into heat, and the heat should be pumped back from the condenser into the boiler, and from the boiler back into the fuel.

But while Carnot's reversible heat-engine exists in the ideal state, we have in the voltaic battery a real reversible engine: for it is possible here to pump back this electric currents into our cell, and even to go further, and to pump into its metallic state the zinc, the fuel which had been consumed in the cell.

Now, while we are thus using currents to separate the zinc from its solution, the zinc is all the while tending to re-unite. Its tendency so to re-unite—its chemical affinity, so-called—manifests itself as a counter-electromotive force; this counter-electromotive force being technically known to electricians under the name of "polarisation." The name is not a happy one, but will do if we once understand its meaning. Polarisation is the electric re-action at the poles or electrodes of a cell, and is of the nature of a counter-electromotive force. To send a current through a cell, we must apply an electromotive force at least as great as that to which the polarisation can attain, or we shall not overcome the tendency of the separate elements to re-unite. In fact, it is in overcoming this polarisation force, that we do the work of storage. We do electro-chemical work by overcoming electro-chemical forces, just as we do mechanical work by overcoming mechanical forces. In every case the storage is effected by overcoming some reaction. If weights that have been lifted, and springs that have been bent, and metals that have been chemically separated, and did not tend to return to their former condition, none of these could serve as vehicles or instruments for the storage of energy. Without reaction, storage of energy would be impossible.

It will next be convenient to glance briefly at the principal laws affecting the counter-electromotive forces of polarisation, that is to say, those electromotive forces which are developed by currents at the poles of the cells, and which tend to oppose a reaction to the currents that evoke them.

Laws of Polarisation.

To tear away an atom of any element from its compound with an atom of another element, requires the use of a definite amount of electricity, and necessitates further that this electricity should be urged forward with at least a certain minimum electromotive force. Take for example the case of the decomposition of water by the electric current. To tear away a single gramme of hydrogen from the oxygen with which it is combined requires no less than 95,050 webers ("coulombs") to flow through. But these liberated and separated gases are in one sense a store of energy, and would, if allowed to combine together (by burning), produce heat. Their "affinity" for one another is very great, and the electric current has to do a considerable amount of work in tearing these two kinds of atoms away from one another. To see what this work amounts to, let us inquire how many units of heat they would evolve in burning. Careful measurements by Favre, Andrews, and Julius Thomsen, show that 34,000 calories of heat would result. Now the work done to separate the gases is of course equal to the work they would do by rushing together.

The affinity of the gases manifests itself as a reaction against the electromotive force of the current employed to separate them. This reaction is itself a counter-electromotive force. When we overcome an opposing electromotive force by pushing a certain quantity of electricity from one point to another against its reaction, we do work just as truly as when we overcome an opposing mechanical force by pushing a certain lump of matter from one point to another against its resistance. In the particular case of the decomposition of water, the opposing electromotive force of polarisation has a magnitude when expressed in the proper units of 1·49 volts. It is possible, when we know how much heat would be envolved by the combination of an equivalent of any substance with oxygen, to calculate the amount of the electromotive force that would have to be applied to tear away that substance from its combination with oxygen. Or, again, suppose we know that of two elements one will, when combining with its equivalent of oxygen, give out more heat than another, then we know that it has a greater affinity for oxygen, and, from the difference between their "heats of combination," we can calculate the surplus of electromotive force that we should have to apply to tear away one of these two from oxygen, and to put the other in its place.

In the accompanying table are given, firstly, the equivalent heat values of the various metals when oxydised and dissolved in sulphuric acid. In the second column are given the electromotive forces that would be needful to tear away these elements from oxygen, or with which they tend to unite with oxygen—the value, in fact, of the electromotive force which measures electrically the chemical affinity of each of these elements for oxygen.

The order in which these metals are arranged is, in fact, nothing else than the order of oxidisability of the metals (in the presence of dilute sulphuric acid); for that metal tends most to oxidise which can, by oxidising, give out the most energy. It also shows the order in which the metals stand in their power to replace one another (in a solution containing sulphuric acid). Thus if copper be put into a solution of platinum, the platinum is reduced,

TABLE OF ELECTROMOTIVE FORCE AS CALCULATED FROM THE HEAT OF OXIDATION OF THE CHEMICAL EQUIVALENT (H = 1 GRAMME), AND AS OBSERVED BY DIRECT EXPERIMENT.

Name of Substance.	Heat Value.	E. M. F.	Electromotive Force observed in Dilute Sulphuric Acid.				
	Calories.	Volts.	With Oxygen.	With Platinum.	With Ozone.	With Peroxide of Lead.	With Zinc.
Potassium	69,800	3·04	...	3·17 (Bf.) 2·484 (Wh.)	...	3·528 (Wh.)	— 1·144 (Wh.)
Sodium	67,800	2·95	...	...	...	...	...
Zinc	42,700	1·862	1·873	1.546 (Po.) 1·439 (Wh.) 1·67 (Bz.) 0·637 (R.)	...	2·448 (Wh.) 2·98 (J.)	0
Iron	34,120	1·570	...	...	...	...	[0·600 (A. and P.)]
Hydrogen	34,100	1·493	? 1·64 (Ta.)	0·86 (R.) 0·877 (Bz.)	1·9 (R.) 2·1 (Wh. Po. Sv.) 2·3 (Bf. Ta.) 2·265 (Ba. Bz.)	? 2·78 (Pl.)	...
Lead	25,100	1.133	...	...	...	2·38 (Pl.)	0·21 (A. & P.) 0·55 (D.L.R.)
Copper	18,760	0·818	0·74 (R.)	0·550 (R.)	...	...	0·953 (Po. 1·079 (L. C.) ·978 (L. C.) [0·75 (A.&P.)]
Silver	? 9,000	...	...	...	...	...	
Platinum	7,500	0·327	...	0	1·21 (R.) 1·04 (R.)	0·6 (R.) 0·75 (R.) 0·90 (Wh.)	1·546 (Po.) 1·439 (Wh.) 1·67 (Bz.) [0·981 (A. & P.)]
Carbon	? 2,000	...	...	...	1·435 (L. Swj.) 1·18 (R.)	...	[1·096 (A. & P.)]
Oxygen	0	0	0	...	...	...	...
Nitric Peroxide	— 6,000	— 0·29	...	...	...	...	1·97 (Bf.) 1·95 (L. C.) 1·96 (Sb.)
Chromic Peroxide	— 7,195	— 0·31	...	...	...	...	2·028 (Sb.
Manganese Peroxide	...	...	...	— 0·54 (Wh.) — 0·101 (R.) — 0·128 (R.) — 0·404	...	0·504 (Wh.) 0·426 (J.)	1·944 (Wh.) 2·55 (J.)
Lead Peroxide	...	...	...	— 0·6 (R.) — 0·75 (R.) — 0·90 (Wh.)	...	0	2·448 (Wh.) 2·98 J.) 2·1 (D'A.)
Silver Peroxide	...	...	...	— 0·7 (R.) — 0·86 (R.)	...	...	...
Hydrogen Peroxide	—10,800	...	...	...	...	...	...
Ozone	—14,800	— 0·645	...	— 1·04 (R.) — 1·21 (R.)	0	...	...

D'A., D'Arsonval; Ba., Bartoli; Bf., Buff; Bz., Beetz; L. C., Latimer Clark; D. L. R., De la Rue; J., Joule; L., Lenz; Pl., Plantè; Po., Poggendorff; R., Raoult; Sb., Sabine; Sv., Svanberg; Swj., Saweljew; Ta., Tait; Wh., Wheatstone; A. & P., Ayrton and Perry (whose observations, being made with an electrometer for contact in air, are placed in square brackets, as not being, like the rest, observations on the electromotive force in sulphuric acid.

and some of the copper dissolves, evolving heat. If however, zinc be placed in a liquid containing a copper compound, it displaces the copper, throwing down the latter as a metal and itself dissolving, while its surplus stored energy runs down as heat. In this order too, the lowest on the list first, are the metals deposited by an electric current from solutions containing two or more of them: for that metal comes down first which requires the least expenditure of energy to separate it from the elements with which it was combined.*

REACTION OF PEROXIDES.

In the preceding discussion, oxygen has been taken as the standard electro-negative substance. But in point of fact there are substances more highly electro-negative; that is to say, substances which when made to combine with a metal such as zinc would give out together a larger amount of heat than zinc does with oxygen. Chief amongst those substances are chlorine and the haloids, the peroxides of the metals manganese, lead and silver, such peroxidised bodies as chromic, perchloric, and permanganic acids, the peroxide of hydrogen, and ozone. If, for example, zinc be caused to combine with an equivalent of peroxide of lead, more heat is evolved than by the mere oxidation of zinc by free oxygen gas. It is clear then that in the unstable chemical aggregation of the peroxide we have a store of energy which can be utilised in giving us voltaic cells of still higher electromotive force. The highly electro-negative (or oxidising) property of the brown peroxide of lead was discovered in 1835 by Munck af Rosenschöld, who describes it as being the most highly electro-negative substance known, being superior even to the peroxide of manganese which Volta found so highly electro-negative. There are, as a matter of fact, several oxides of lead, containing least oxygen of all these oxides; *minium* or red lead, containing a greater proportion; and the *brown* peroxide, with the highest proportion of oxygen, the best conductor and the most highly electro-negative of them. The peroxide of silver is still more highly electro-negative. This power can easily be verified by making a small voltaic cell with a pair of plates, the one platinum covered with a film of peroxide of lead, the other of zinc. One such cell will decompose water, which a copper-zinc pair will fail to do. For to do this requires, as may be seen by the table, an electromotive force exceeding 1·493 volts, this being the measure of the affinity of hydrogen for oxygen. The platinum-zinc pair would have an electromotive force of only 1·044 volts, while that of a peroxide of lead-zinc pair is about 2½ volts.

MINIMUM ELECTROMOTIVE FORCE FOR CHARGING.

The electromotive force of polarisation in a cell, evoked there by the passage of a primary current through it, will depend upon what circumstances are produced at the two electrodes by the passage of the current. In the case of all ordinary liquids and metallic solutions, the products are known.

For each electrolyte there is a minimum electromotive force, without which, complete decomposition cannot occur. For water, for example, this minimum is 1·495 volts. If the current be of less electromotive force than this minimum, the action may begin, but the charging current will be stopped the moment the opposing electromotive force of polarisation has risen to an equal amount. It is for this reason that in charging a Planté cell, or a Faure cell, we must use at least two cells of Grove's or of Bunsen's battery, or at least three cells of Daniell's battery.

The chemical work that is done in any secondary battery, or electrolytic cell, is proportional to the strength of the charging currents, to the time it lasts, and to the effective minimum electromotive force of polarisation in the cell itself. It is not increased by increasing the electromotive force of the charging current much beyond this value; for though a higher counter-electromotive force may be temporarily called out, the work done against this added opposition is wasted in local heat, which is detrimental to the power of the cell. The cells should be charged with only just sufficient electromotive force to overcome their reaction. To charge a Planté cell, two Bunsen cells—not twenty—should be used. The storage will be slower, it is true, but it will be more economical, by far.

STORAGE POWER LESSENED BY HEAT.

Heat diminishes the counter-electromotive force of the cells during charging; it therefore diminishes the amount of chemical work done in charging them, and diminishes the amount of charge thereby stored. Secondary batteries should be kept as cool as possible during charging. A simple experiment in proof of the diminution of polarisation by rise of temperature is the following. Let a single Grove's cell be connected with a water-voltameter: no gases are evolved until the voltameter is heated to near boiling, when the gases come off freely. Bartoli examined the electromotive force of polarisation in a cell containing sulphuric acid with electrodes of platinum, and found it to be twice as great when the liquid was at 5° C as when raised to its boiling-point. Beetz and and Robinson have independently investigated the same effect, and their results agree precisely. Beetz found the polarisation 2·216 volts at the ordinary temperature of 20° C, and as the temperature was raised it fell off, gently at first, more rapidly afterwards, till at 100° C it was only 1·904 volts.

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* The calculation of the figures in the second column (the electromotive forces) from those of the first column (the number of the calories of heat evolved by the oxidation and solution of that amount of the substance that is chemically equivalent to one gramme of hydrogen) is effected in a manner originally suggested by Mr. Joule and Sir William Thomson. The number of heat units or calories is ascertained by direct experiment in the calorimeter in the manner familiar in the researches made on heat of combination by Favre, Andrews, Julius Thomsen, and Berthelot. Now, Faraday showed that the qualities of metals concerned in the electro-chemical operations in voltaic and electrolytic cells are proportional to their chemical equivalents; and the later researches of Weber, Kohlrausch, Mascart, and Alder Wright have shown that this proportionality can be expressed by a numerical co-efficient, which we may call the "Faraday co-efficient," and which will depend on the unit in which electrical qualities are expressed. If we take the coulomb (or "weber", as the unit of electric quantity, then the Faraday co-efficient is 0·000105 or, in other words, each weber (or coulomb) of electricity which passes through a cell will involve the liberation or combination of 0·000105 grammes of that element, whose chemical equivalent is 1, and proportionally more of those whose chemical equivalents are greater. The heat value of the chemical work done by one weber (or coulomb) of electricity, in removing or depositing any metal in any cell, is obtained by multiplying by 0·000105 the figure standing opposite the metal in question, in the first column of the table. These heat values are turned into absolute units of work by multiplying by Joule's mechanical equivalent of heat, which is, in the centimetre-gramme-second system of units, equal to 41,530,000, or $41·53 \times 10^6$. But the work done in moving a unit of electricity against the reaction in a cell measures the power of that cell to react electrically, or, in other words, measures its electromotive force relatively to oxygen, which is taken here as the standard electro-negative substance. These electromotive forces will be expressed in terms of the appropriate of electromotive force, the volt.

Temperature.	E.M.F. (Beetz).	E.M.F. (Robinson).
16° C.	2·216	..
20°	..	2·216
30°	..	2·194
43°	..	2·148
53°	..	2·105
57·5°	2,101	..
60°	..	2·095
80°	..	2·040
94°	1·960	..
100°	..	1·904

IMPORTANCE OF SUFFICIENT CURRENT DENSITY.

The influence on the polarisation-force of a cell of the size of the plates used as electrodes relatively to the strength of the charging current has also been investigated by several experimentors, amongst them Crova, Poggendorff, and Bunsen, and more recently by Bartoli and Blondlot. It is found that the degree to which a counter-electromotive force or polarisation force is set up depends very greatly on the quantity of current per unit of surface of the electrodes employed. If the current be weak, and the electrodes large, the polarisation never reaches its maximum. On the other hand, if the electrodes be very small surface, and the current a strong one, the polarisation may attain abnormally high values. Thus Buff, electrolysing water with small platinum points, found the counter-electromotive force to be no less than 3·57 volts. This difference between this and the minimum value of about 1·493, must be accounted for by the fact that the state of the liberated products varies with the condition of liberation. With greater "current density"* the gases liberated by decomposing water are no longer simple oxygen and simple hydrogen. With greater current-density, a greater proportion of the oxygen comes off in the more highly electro-negative condition of ozone, and more peroxide of hydrogen forms also round the anode, whilst at the kathode, the hydrogen which is evolved possesses in unusual degree the active properties attributed by chemists to "nascent" hydrogen; that is to say, a larger proportion of it probably is, at the moment of liberation, in some abnormal allotropic condition, bearing the same kind of relation to ordinary hydrogen as ozone bears to oxygen. The allotropic hydrogen is more oxidisable; the ozone more ready to oxidise. Their union would evolve more heat than the union of equal weights of ordinary hydrogen, and ordinary oxygen. It requires greater electromotive force to keep them apart; their own tendency to unite is greater. J. Thomsen has even measured the heat value of ozone as compared with oxygen, and it takes its place in our table of elements at the bottom below the peroxides, though chlorine and the haloids would be still lower on the list if they came within the scope of present considerations.

It follows from the above argument, that if we wish to make our storing cells exert their highest possible reaction, we must store them, using a current whose strength (or quantity) is proportioned to the size of the cell. If we use too weak a current, the maximum polarisation, and therefore the maximum efficiency, will never be attained. This is one of the rocks on which amateur constructors of storage batteries have come to grief. The current-density* is a most important consideration, especially in the early stages of the formation of the cells. It certainly should not be less than 50 milliwebers per square centimetre of surface in the cell.

EFFECT OF STATE OF SURFACE.

Again, the state of the surface of the electrodes has much to do in determining the state in which the gases are liberated, and the resulting polarisation force. Svanberg, in electrolysing water with copper electrodes, found the polarisation to be ·72 volts with smooth plates, and only ·47 with corrugated plates. Poggendorff, using platinum plates, found the maximum polarisation to be—with bright surfaces, from 2·28 to 2·50 volts; while with surfaces platinized, *i.e.*, coated with a black, powdery deposit of platinum, the polarisation in cells, like those of Planté and Faure, where the original surfaces of the plates of lead are coated with thick films of peroxide, or of reduced metal, these considerations do not apply, except for the first operation of charging. Indeed, I have found, experimentally, that there is a gain in scratching the leaden surfaces, before forming the coating of peroxide; the coating is more adherent, and the effective surface somewhat greater; advantages beside which the greater preliminary waste of liberated gases on first charging is comparatively trivial.

We will next take a brief historical glance

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* This term means "the amount of current per unit of surface of the electrodes," and is calculated for either electrode (in the simple case of parallel plates), by dividing the total strength of the current in webers *(ampères)* by the area of that electrode in square centimetres.

* Crova, and more recently Bartoli, have given exact formulæ, by which to express this important relation. Let P represent the E.M.F. of polarisation at any time: it can be expressed as a function of the possible maximum polarisation and of the density of the current. Let A be this possible maximum E.M.F.; s = the surface (supposed uniform), q the time t (supposed short), then

$$P = A\left(1 - 10^{-a\frac{q}{s}}\right)$$

where a is a constant (8,400 circ.) This may be interpreted as follows:—The polarisation falls short of its pessible maximum by an amount the logarithm of which is inversely proportional to the current density.

at the various stages in the invention and perfection of accumulators or storage batteries.

HISTORICAL SUMMARY.

Within one year after the discovery of the pile by Volta, two very important observations had been made. Nicholson and Carlisle, in 1800, discovered that the current so produced could decompose water;* and in 1801 Gautherot discovered that the wires of platinum or of silver which had been employed to thus decompose salt water acquired, and retained after being detached from the pile, the power of yielding a transient current, as could be proved by their efficacy in causing muscular contractions in a frog's leg, and in yielding the so-called galvanic taste. This is the phenomenon afterwards denominated "the polarisation of the electrodes." It was found to consist in a peculiar state of the electrodes which manifested its presence, even before the exciting current of the pile was cut off, by producing an enfeebling reaction against that current, the polarisation current being in a direction which opposed the exciting current. The phenomenon is well known to all electricians, and occurs not only in electrolytic cells, but in the cells of the voltaic batteries, where the liberation of hydrogen bubbles is accompanied by an opposing reaction of the same kind. Indeed, the difficulty with batteries has been to get rid of the polarisation.

In 1803, Ritter, of Jena, re-observed the same phenomenon, using wires of gold; and perceiving the importance of this reaction, he constructed a secondary pile which we will presently describe.

The phenomena of the secondary currents due to polarisation were further investigated by Volta, Marianini, Davy, Grotthuss, De la Rive, Sinsteden, Becquerel, Schœnbein, Matteucci, Grove, Faraday, Buff, Beetz, and others. Matteucci and Grove in particular studied the reaction-currents set up by the presence of uncombined gases at the electrodes, and the latter constructed a well-known "gas battery." In 1869, M. Gaston Planté brought out a secondary battery constructed of lead-plates dipping into sulphuric acid, and in a remarkable and valuable series of classical researches, he investigated the phenomena of their action. More recently, modifications of the Planté accumulator have been suggested by M. Camille Faure and M. A. de Méritens. These various systems will be described in detail presently. Professors E. J. Houston and Elihu Thomson, of Philadelphia, have made the suggestion which embodies the principle of reversibility in the case of the Daniell's cell. They place two horizontal copper plates in a cell containing sulphate of zinc in strong solution. To change this cell, a current is sent through it from the top plate downwards. The upper plate or anode dissolves, forming a solution of sulphate of copper, which, being specifically lighter, floats on the sulphate of zinc. On the lower plate, metallic zinc is deposited; so that, when charged, this battery is merely a "gravitation Daniell" battery. It will afterwards yield a current so long as there remains any zinc in the metallic state, or so long as there exists a chemical difference between the two electrodes. This suggestion has been modified by M. d'Arsonval, who uses an electrode of lead, or of carbon covered with leaden shot along with an electrode of zinc in sulphate of zinc. In this case, when the cell is charged, zinc is deposited upon the zinc plate, while the lead becomes peroxidised.

Other suggestions have come still more recently from M. J. Rousse, who proposes the use of ferro-manganese, and of palladium as electrodes. The advantages offered by the former alloy over zinc do not appear to be great; and the cost of the latter metal is so enormous as to render suggestion valueless for practical ends.

RITTER'S SECONDARY PILE.

Ritter discovered the possibility of secondary voltaic action while studying the chemical action of electric currents upon liquids. He employed a large voltaic pile as his source of electricity, and observed, not only the decomposition of water into oxygen and hydrogen, but the phenomena of formation of peroxides, and of the deposition of metallic films at the anode and kathode respectively, when metallic solutions were employed. He found that his gold wires, after becoming covered respectively with film, if separated, oxygen and hydrogen could set up violent contractions in a frog's leg. He further investigated the phenomenon with differenr kinds of wires, and found platinum to yield the best result., gold coming next in order, then silver, copper, and bismuth. With lead, zinc, and tin, however, he obtained no result. He further showed that even after having been removed from the water and dried, the pair of gold wires retained their activity, and when afterwards plunged into water yielded a current in a direction opposed to that of the pile, by which they were originally rendered active.

One remarkable experiment of Ritter's found its way into English journals. Ritter took a *louis d'or*, and placing moistened cloth against its two sides, proceeded to pass through this combination a current from a powerful pile. The coin still laid in its wrappings was afterwards found capable of furnishing a current. This led Ritter to propound the view that conductors of electricity, such as the metals, could be charged with electricity; the coin between its metal wrappings being, according to him, the analogon of the Leyden jar lying between its two coatings of tinfoil. He mentions also mercury, carbon, graphite, and binoxide of manganese, as being capable of receiving galvanic charges. "Each of these bodies," he says, "becomes charged upon both its sides just like the glass of the Leyden jar, and this state of charge, when it exists in such concentration or intensity, as in the foregoing bodies, is perceived as a state of oxygenation on one side, and a state of hydrogenisation on the other." He also draws attention to the curious behaviour of quicksilver, which, when placed between water and water, and included in the circuit of a voltaic pile, shows movements due to changes in surface-tension where the films of gas are produced. Ritter advanced to the rather unwarranted conclusion that, since in these cases the charge stored up depended on the pressure of oxygen and hydrogen films produced from the water, there must necessarily be water in all bodies, and that chemical separation always accompanied electric charge.

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* Water had previously been decomposed by discharges from an electric machine in 1789, by Paetz van Troostwyk and John Cuthbertson.

To produce these effects of galvanic charge upon a larger scale, Ritter constructed a secondary pile *(Ladungs-Saüle)*, consisting of a series of discs, of one metal—copper—separated by pads of cloth, moistened with a solution of salt, or sal ammoniac. When charged from a voltaic pile of ordinary construction, this secondary pile received a charge, which afterwards enabled it to give a shock to a person touching its two ends with his hands. It would also decompose water, and, in short, reproduce all the effects of the primary pile, but reversed as to the direction of the currents it furnished.

Ritter was not happy, however, in all his efforts to explain what he observed. He founded his argumeuts on the incorrect supposition that oxygen consisted of water, combined with negative electricity. It was some years before the researches of Volta, Marianini, and Schönbein, placed the phenomena on their true basis; Schönbein adding the very valuable observation that the presence of ozone in the liberated oxygen intensified the secondary electric action.

PROGRESS IN ELECTRO-CHEMICAL KNOWLEDGE.

The researches of Davy, De la Rive, and of Faraday, upon the chemical phenomena of the voltaic cell, showed that the chemical decompositions within the battery were amenable to the same laws as those which took place in an electrolytic cell at a distant point of the circuit. Faraday brought out several most valuable points in his "Experimental Researches." He describes (Art. 750) how, in electrolysing acetate of lead, "in place of oxygen, or even the gases already described, peroxide of lead now appears at the positive,[*] and lead itself at the negative pole." In his argument for the chemical theory of the cell, he remarks that while those substances are highly electronegative which cannot be oxydised, there is another class of substances still more highly electro-negative, namely, those substances which readily give up oxygen, the peroxide of manganese being more negative than platinum, as Volta showed, and the peroxide of lead being still more negative than that of manganese, as Munck af Rosenchöld had shown. Faraday remarked (Art. 1822) on the good conducting power of the peroxide of lead. He also observed that red lead is more negative than platinum. De la Rive indeed utilised the strong electro-negative property of peroxide of lead in the construction of a cell in which this substance, packed in a porous pot around a platinum strip, served as one pole, zinc being the other. Niaudet, in his treatise on the "Pile Electrique" (published 1878), suggests that red lead (minium) would have answered equally well. In the Bakerian lecture for 1843, Wheatstone announced that he had measured the electromotive force of peroxide of lead against zinc, and had found it to be 2·266 of that of a Daniell's cell, (= 2·448 volts.)

GROVE'S GAS BATTERY.

In 1842, Sir William (then Professor) Grove described the well-known gas battery, which was indeed nothing else than a reversible oxygen and hydrogen battery, in which work had first to be done to produce chemical decomposition, electric currents being passed through acidulated water from one platinum pole to another, these currents being of sufficient power to overcome the opposing mutual affinity of the constituent gases, the reaction of these separated gases tending to produce a counter-current of considerable power, and manifesting a so-called electromotive-force of polarisation.

The rationale of the gas battery is simple enough, provided it be once understood that platinum possesses a power almost unique amongst the metals, of absorbing upon its surface both oxygen and hydrogen gas. When a current is passed between platinum electrodes in acidulated water, the two gases not only rise in bubbles, but form a film at or in the surface of the metal, which when so charged behaves differently from neutral clean platinum. The hydrogenised film resembles zinc or some oxidisable metal, and exercises toward clear platinum, and *a fortiori* toward oxygenised platinum, a strong electromotive force. The energy spent by the decomposing current in separating these gases, is stored in the gases that are thus separated. In their subsequent reunion, the energy of their separation runs down into some other form; into heat if the gases are merely mixed and exploded together; into the energy of electric currents if the gases are suffered to recombine through the liquid, by the slower and cooler process of slow chemical combination in the cell.

With a gas battery of 50 pairs, Grove produced electric lights, effected various chemical decompositions, and produced shocks which could be felt by five persons joining hands.

PLANTE'S SECONDARY BATTERIES.

M. Gaston Planté, to whom, more than to any other experimenter, the recent advances in the practical construction of storage-batteries are due, very carefully re-examined the whole question of the polarisation of electrodes, using different metals as electrodes, and different liquids as electrolytes, and found that the greatest effective polarisation was produced when dilute sulphuric acid was electroysed between electrodes of lead. Similar researches, though less complete, had been made before by Sinsteden, Poggendorff, Daniell, Lenz, and Saweljew, and by Edmond Becquerel. Sinsteden had even obtained from leaden electrodes polarisation currents of sufficient power to raise a thin wire to incandescence. These researches had mostly been undertaken with the view of ascertaining the cause why the currents furnished by most of the voltaic combinations then in use fell off so rapidly in strength. The result of these researches was to suggest methods of getting rid of the residual polarisation and its tendency to set up an opposing countercurrent.

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[*] Professor Adams, commenting on this observation of Faraday's, shows that Faraday thus anticipated Planté in the discovery of the leaden cell. But a Planté cell filled with acetate of lead is almost useless. The fact that peroxides are thus deposited on the anode was thus discovered before Faraday's researches by Nobili, who noticed also the beautiful irridescent colours in the rings of peroxide films deposited on an anode plate opposite a printed kathrode; the phenomenon known usually as *Nobili's* rings.

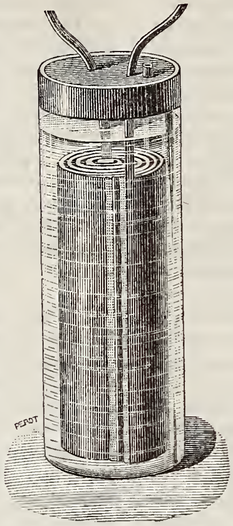

Fig. 1.

M. Planté, however, struck out in an opposite course, and endeavoured instead to find the best means of provoking the phenomenon of polarisation, in order, as he expressed it, to turn to profit the secondary currents and to accumulate the energy of the battery. He was, therefore, led by his preliminary researches in 1860 to construct a secondary battery consisting of nine cells, in each of which two long and wide strips of lead, separated by coarse cloth, were rolled together in a spiral form, and immersed in dilute sulphuric acid. (See Fig. 1.) A few months later he modified this form by placing side by side in a rectangular box two series of lead plates, alternately connected together, each plate being about eight inches long and nine inches high. He recurred afterwards to the spiral form as being more convenient, but replacing the coarse cloth by narrow strips of gutta-percha.

But the cells thus constructed were not ready for immediate action. Two clean lead plates give no current of their own; they are only intended to receive and store up what is sent into them from some external source. And at first, while the lead is bright, when a current is sent through the cell from some suitable source, such as three or four Grove's or Bunsen cells, the separated oxygen and hydrogen gases bubble up to the surface, for the most part, leaving only a very small per-centage as an adherent film, and, in consequence, yielding only very transient secondary currents. The plate of lead by which the current enters is, however, attacked by the oxygen, and becomes covered by a thin layer of brown peroxide of lead, and this film, though thin, is powerfully electro-negative toward metallic lead, and toward the film of hydrogen on the kathode plate. The cell in this condition will therefore produce a current, and in so doing, the peroxide is partially reduced to the metallic condition, and assumes in its reduction a spongy, or loosely crystalline texture. If now the cell be again charged, and charged in the opposite direction, the other plate of lead becomes, in like manner, peroxidised, while the hydrogen bubbles are less freely evolved, for the atoms of gas unite as fast as they are liberated, with the oxygen of the peroxide, and reduce it to the metallic condition. Every time the charging current is thus reversed, the films of peroxide, or of spongy metal, become thicker until the lead to a considerable depth is bitten into. And every such operation increases, therefore, the power of the cell to store up in this electro-chemical fashion the energy of the currents sent into it. M. Planté, who minutely describes the process of "forming" the cell, compares it to a sort of electro-chemical *tanning.* The first day, the alternate charging should be done at intervals of a quarter to half-an-hour, the cell being discharged between each operation. The next day, the duration of the alternate charges may be increased from a quarter-of-

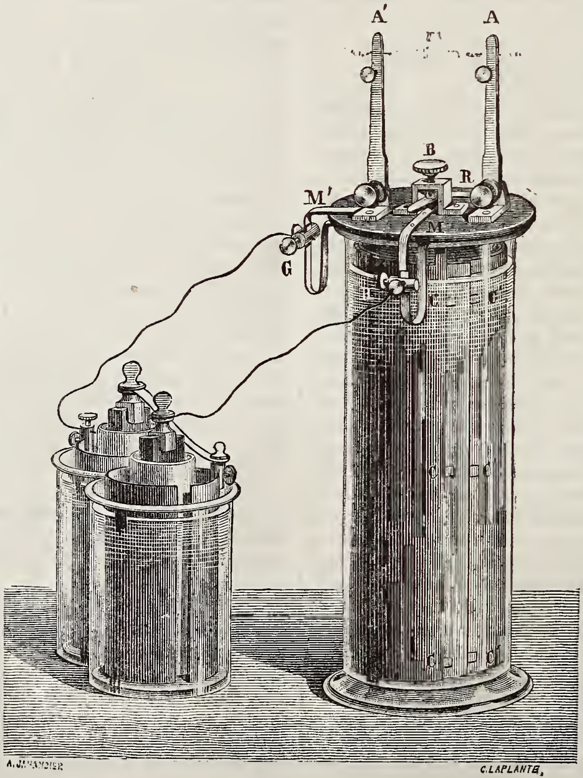

Fig. 2

an-hour to a whole hour; the day after to two hours. After repose for a week or a fortnight, the charges may last several hours; and by the end of several months, the cell will be well "formed;" after which it should, when used, be charged in one direction only, otherwise, the whole thickness of the lead plates will be bitten into and transformed into peroxide.

The electromotive force thus developed in a fully charged Planté cell may be as much as 2·38 or even 2·7 volts; and as the large area and close proximity of the plates diminishes the resistance of the liquid to a very small quantity, such cells are capable of furnishing a very powerful current* for a few minutes, and their calorific power is considerable. In fact, they discharge themselves too well, and run down too soon for many purposes. A single cell 10 inches high will, however, suffice to keep a platinum wire, 2 inches in length and $\frac{1}{100}$ inch in diameter, glowing at a bright red heat for three-quarters of an hour. (See Fig 2.) The amount of charge will, of course, depend on the size of the plates and on the degree to which the process of "formation" has been carried out. It may be charged by using two or three Grove's or Bunsen's cells, or by the current of a dynamo-electric machine. A single Grove's or Bunsen's cell will partially charge a Planté accumulator, but cannot raise it to its full power, because the electromotive force of such a source is only 1·9 volts, or less than that of the cell at full power. The cells, when in good condition, will retain their charges for many days, though there is a gradual decay in the charge, owing probably to internal electrolytic convection in the liquid. During discharge the current is evolved with great constancy until quite near to the end of the operation, when there is a sudden falling off. This effect is very remarkable, and arises probably from the conditions of internal resistance, both in the peroxide films, and in the liquids. A Bunsen battery of small size and considerable internal resistance will take some hours to charge a cell fully; while a dynamo-electric machine may fully charge it in half-an-hour; but the rate of discharge will be alike in each case. The secondary battery plays, therefore, a controlling part in the rate at which such actions may go on. I am inclined to think that the well-known action of a damp string in retarding sparks of a Leyden jar, is due to a similar kind of action. Another curious fact concerning Planté's accumulator is that, after having been rapidly discharged, and left to itself, it will presently yield a small residual current: a phenomenon strikingly similar to that of the residual spark in the Leyden jar. In consequence partly of these useless residual charges, and partly also because a fraction of the energy of the charging current is wasted in heat in the cell, there is a loss of about 11 or 12 per cent. between charging and discharging. M. Planté states that voltametric measurements show that of the whole current 88 to 89 per cent. is given back by the cell. According to M. Géraldy a Planté cell containing 1·445 kilogrammes of lead can store 4·983 kilogrammètres of energy, being at the rate of 3·45 kilogrammètres per kilogramme, or 11·329 foot-pounds per pound.

M. Planté has devoted much attention to the effects produced by uniting these secondary cells when charged, in series, so as to augment their effects. By grouping them in a box with a Müller's commutator above them he is able to charge them in parallel arc, and discharge them in series. Twenty cells will thus furnish for a few minutes an electric arc light. With a large battery of 800 cells thus arranged, M. Planté has carried out a number of fine experiments of the highest theoretical and speculative interest, and destined some day to bear fruit in practical applications. He has further devised an instrument, known as a "Rheostatic Machine," consisting of a number of mica condensers connected with a rotating commutator, by which they can be charged in parallel arc, and discharged in series, which, when supplied by the large battery of 800 cells, yields sparks 12 or 14 inches in length, and produces effects which otherwise can only be produced by statical (frictional) electric machines, or by the use of the induction coil. He has observed, amongst a host of other wonderful things, a very remarkable case of globular discharge, the exact counterpart on a small scale of the much-disputed phenomenon of globular lighting.

APPLICATIONS OF PLANTE'S ACCUMULATOR.

Since 1872, the Planté cell has been regularly used for the operations of cautery. M. Trouvé, the well-known maker of electrical instruments in Paris, has brought out a whole series of little surgical appliances adapted for use with the Planté cell, including little incandescent lamps to illuminate the cavities of the body—as for example to aid the surgeon in operation upon the larynx—and dentists' appliances for destroying the nerves in hollow teeth. By the kindness of Professor W. F. Barrett, of Dublin, I am enabled to exhibit one of these medical cells, and the various appliances of galvano-cautery adapted for use with the same. The advantage of employing a secondary cell for such a purpose, is that such cells may be made of a higher electromotive force, and of a smaller resistance than any single cell of any primary battery yet invented.

M. Planté, in 1860, suggested that his accumulators might be usefully employed in telegraphy, instead of the voltameters with platinum electrodes as Jacobi proposed, in order to obviate the retardation in the transmission of signals, caused partly by induction and partly by the residual magnetism of the electro-magnets of the instruments. The opposing current set up in the secondary battery which is in the circuit, being in the contrary direction, sweeps out the residual magnetism and the residual static change so soon as the working battery is cut out of the circuit.

Another application brought out by M. Planté is to the purpose of obtaining a household light, which will serve instead of a match-box when it is desired to light a candle or a jet of gas. The "Briquet de Saturne," as he has whimsically termed this new-fashioned tinder-box, is merely a small accumulator charged by four little Daniell's cells, and provided with a "push," that, when pressed, completes the circuit, through a small strip of platinum foil, which glows with a red heat.

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* The E.M.F. being 2·38 volts, and the resistance as small as from 0·12 to 0·048 ohm, the current through a short stout wire may be considerably over 20 webers (*ampères*).

At the suggestion of M. Achard, Planté's accumulators have been employed to actuate a brake on a railway train. To work a brake a great power is required for a short time. This can be done by employing large electro-magnets to move the mechanism of the brakes, the electro-magnets being excited by six Planté cells which distribute power to a dozen different brakes. As the charge stored would last but ten days, six Daniell's cells are also added to provide a constant, though feeble, source of current to keep the accumulators charged, and during the instant when the brakes are put on, the six Daniell's add their feeble share to the total effect. More recently M. Trouvé has employed a battery of six Planté accumulators, to propel a tricycle through the streets of Paris, attaining a speed of about 10 miles per hour. The comparative lightness of the cell in proportion to the mechanical power it can evoke in a small electro-magnetic motor, giving a great advantage in this case over a small steam-engine. Trouvé has also fitted a small pleasure boat, with a similar apparatus. If very thin laminæ of lead—lead foil in fact—be employed to form the cells, still greater lightness may be attained in proportion to accumulating power, though, probably, at the expense of durability. This possibility has tempted M. Gaston Tissandier to propose to steer, or even propel, balloons or other aeronautical vehicles by electrical means.

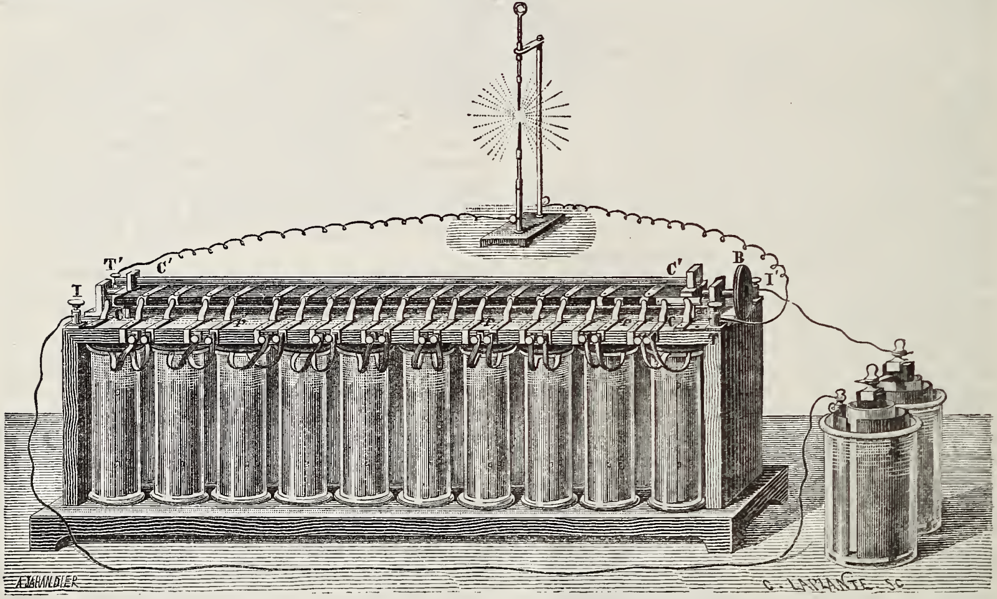

FIG. 3.

M. Niaudet has shown how the Planté accumulator may be utilised in naval signalling. His suggestion is to exhibit flashing electric lights of great brilliancy, but of short duration; the source being a series of accumulators which, during the intervals of darkness are being steadily replenished by a constant battery, or by the currents from dynamo-electric machines. There seems, indeed, no reason why a complete system of signals should not be arranged for ships on the principle of the system of flashing lights, suggested by Sir William Thomson for lighthouses. And there can be no question that were such a system adopted, many collisions at sea might be saved.

Yet another advantage of the system of accumulation, as carried out by M. Planté in his ingenious grouping of the cells, with the rotating commutator described above, and shown in Fig. 3, is that with only two Bunsen cells as a source of currents, a powerful electric light can be maintained for a short time. For colleges, and schools, and scientific lectures, when an occasional flash of electric arc light is wanted for some temporary purpose, without incurring the labour and expense of setting up 50 Grove cells every time, an accumulating battery is of great value.

APPLICATION TO PHOTOGRAPHY.

I would also draw attention to the great value which such an arrangement offers to photographers, who may desire to have at hand a source of brilliant and white light, with small expenditure of capital and of daily labour.

I mention these applications before dealing with more recent forms of accumulator, because there appears to be an amount of ignorance in the scientific world that is simply inexplicable, with respect to the magnificent researches carried on by Planté through more than twenty years, and the variety of useful applications to which his accumulator had been put before even the fame of more recent inventions had been noised abroad—before they had even been made at all.

We now pass to some of the recent modifications of the Planté accumulator, the principal amongst them being those of M. Faure and of M. de Méritens.

FAURE'S ACCUMULATOR.

In 1880, M. Camille Faure conceived the idea of constructing a secondary battery, in which, though the tedious process of "formation" by Planté's process is modified and shortened, the ultimate result is the same, namely, to produce upon lead plates, immersed in dilute sulphuric acid, a coating of peroxide of lead, that can readily be reduced to the loosely crystalline metallic condition. This M. Faure accomplishes by the device of giving to his leaden plates a preliminary coating of red lead (minium), made up into a paste with dilute acid, and painted upon the surface. At first he adopted the spiral form of cell, the two plates being separated by felt or leather. More recently the rectangular form has been reverted to. The present mode of construction is as follows:—Eleven sheets of lead of such thickness as to weigh about 2 lbs. to the square foot are cut to the size of 12 inches by 10 inches, an ear-piece being burned on at one corner. Or six sheets are taken; five of them being twice the above size, and folded double, in the way shown in Fig. 4. These are painted thickly with red lead on both sides, and against each side is pressed a piece of felt, the face of which is also thickly coated with red lead; there being about 17 lbs. of lead and 25 lbs. of red lead altogether. These sheets are placed side by side in a water-tight case, alternate sheets being connected together by the projecting flaps. The general aspect of the cell is shown in Fig. 5. The cell is filled up with dilute acid; the total weight being about 50 lbs. When thus prepared, the cells are "formed" by a process of charging by means of the current of a dynamo-electric machine, the current being sent through them for six or seven days without intermission before they are ready for use. The red lead is reduced gradually on one side to the metallic state, and on the other assumes the condition of peroxide: but the cell does not attain its best condition for some weeks. As it is important that the electromotive force of the charging current should not much exceed that of the cells (2·38 volts), it is usual to charge a number of cells in series. The internal resistance of such cells is stated as being less than ·01 ohm. The advantage of this system of construction is not confined to the saving in time of formation: there is the further advantage of thus obtaining a much thicker film of the working substance than in the Planté accumulator: though with the difference that the deposit of peroxide is not so regular in its structure. According to Sir William Thomson, a single cell of the spiral form weighing 75 kilogrammes (165 lbs.) can store 2,000,000 foot-pounds of energy, or one-horse power for one hour. Their action is more economical, however, when the charge is not drawn upon at this rapid rate. Economy in working is found to accompany slow and regular discharge. Five or six hours is a more economical time for discharge, and then the waste is believed not to amount to more than ten per cent. Sir William Thomson states, that the probable loss of energy in charging is 10 per cent., and in discharging 15 per cent.; but he thinks it will be advisable in practice to be satisfied with less perfect economy than this. According to Reynier, a Faure cell, containing 56 kilogrammes of lead, can store 210,000 kilogrammètres of electro-chemical energy; or at the rate of 3·75 kilogrammètres per kilogramme of lead, or 12·85 foot-pounds per pound of lead. According to M. Géraldy, the figure is slightly less, being only 3·28 kilogrammètres per kilogramme, or 10·76 foot-pounds per lb. Such a cell, when on short circuit can, I am informed, furnish for ten hours a current of 10 to 14 webers continuously.

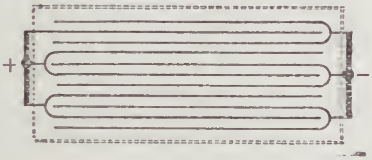

FIG. 4.

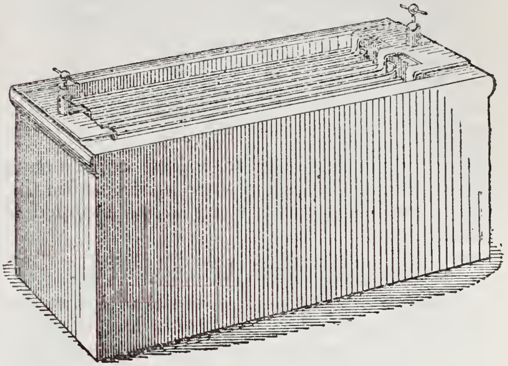

FIG. 5.

M. Faure is now constructing larger cells, of which, by the kindness of Major Ricarde-Seaver, I am enabled to give the following details:—The leaden plates are about 17 inches long by 12½ wide. About 50 pounds of red lead are used; and the sixteen sheets of lead themselves weigh about 20 lbs. The sheets which are to serve as positive electrodes are eight hundredths of an inch thick; those which are to serve as negative electrodes are four hundredths of an inch thick. After being painted with red lead they are folded up, first in parchment paper, and then in felt, and placed in a rectangular box, with narrow strips of indiarubber to prevent contact. Such a cell requires about 16 lbs. of dilute sulphuric acid to charge it. The total weight is about 135 lbs. for each cell. One of these cells, when placed on a circuit of small resistance, in which one of Ayrton and Perry's galvanometers was included, gave the following values of current:—

For 8 hours 22 webers = 176 weber-hours.
4 ,, 21 ,, = 84 ,,
1 ,, 20 ,, = 20 ,,
1 ,, 19 ,, = 19 ,,

Total 14 hours. 229

or on an average over 20 webers continuously for 14 hours. The discharge went on after this for seven hours more, when it had stopped to five webers.

DE MERITENS' ACCUMULATOR.

Another modification of the Planté accumulator has been devised by M. De Méritens. In this cell the plates of lead are made up of thin laminæ, folded one upon another like the leaves of a book, or more strictly, like the laths of a venetian blind; the whole being soldered to a stouter framework of lead. The object of this arrangement is to secure a greater amount of effective surface. Two such compound plates are set side by side in a box containing acid: no felt or other separating material being used. The plates require "forming," however, by a longer process than in the Faure cell. This accumulator has been highly spoken of, and showed admirable results at the late Electrical Exhibition in Paris. No examples have yet been brought to England, and I am not aware of any exact measurements having been made of their power or capacity. It is, weight for weight, far more powerful than Faure's cell; and therefore, power for power, is of smaller bulk.

OTHER MODIFICATIONS.

In investigating the properties of secondary batteries, I have tried a number of modifications of the Planté accumulator, with varying success. I have found that almost any oxide or hydrate of lead will answer instead of red-lead for the purpose of providing, as in the Faure cell, a material to be converted by a process of formation into the peroxide of lead. Litharge answers well if sufficiently finely divided before being painted on. White lead will even answer, but not so well. Litharge mixed with a small proportion of binoxide of manganese works well. The formation is rapid, but at first the electromotive force is not so high as in the Planté cell. It rises, however, as the process of formation proceeds. The binoxide of manganese is not (see table) so strongly electro-negative a substance as the peroxide of lead. Its presence in the final state would lessen the electromotive force. But happily the manganese gradually dissolves into the acid when its function as an agent to assist the lead in peroxidising is fulfilled, and by changing the acid a few times it is finally eliminated. The most satisfactory cells I have yet tried were made by painting the lead plates with a coat of the brown peroxide itself, which is obtainable in commerce, though its cost is about four times that of red lead or of litharge. I find this process by far the most expeditious for making up cells; as indeed might be expected, since it is obviously a stage towards simplification to put on to the lead plates a coating of the very substance which we desire ultimately to produce there. Examination of the plates of a cell in which the process of formation has only just begun, shows that the lead surface must itself be peroxidised and bitten into before the useful action extends to the contiguous portions of oxide or peroxide painted over it, and in some stages a yellow suboxide, probably essentially litharge, appears to be produced as an intermediate product of the reduction of the oxide at the kathode. Of this intermediate yellow product, however, I can find no trace in well-formed cells. As the reduction and peroxidation of the coating only begins where peroxidation of the leaden sheet has begun, the relation of density to maximum polarisation, pointed out in an earlier paragraph of my paper, becomes of extreme importance. Plenty of current, and yet of an electromotive force only just exceeding the maximum electromotive force of the cell, is the rule for charging in the early stages of formation. Could a spongy lead be produced by any simple metallurgical process—like the spongy iron of Bischoff's filters—it would probably prove an admirable substance from which to form electrodes for accumulators.

COMPARISON OF PLANTE'S AND FAURE'S ACCUMLATORS.

No very reliable comparisons between the accumulators of Planté and those of Faure, or of De Méritens, have yet been made. Seeing that in each of these, when completely formed, the materials are the same—namely, lead and peroxide of lead immersed in dilute sulphuric acid—the maximum electromotive force must be eventually the same in each. The resistance of a cell is simply a question of size and shape. The relative strength of current actually furnished by these cells should therefore merely vary with their dimensions. The presence, however, of the felt, and its coatings of red lead, introduces resistance into the Faure cell, and as some recent determinations of M. Achard show, a Planté cell will heat a greater length of platinum wire, and do its work three times as quickly as a Faure cell, whose surface is of the same amount. One would also expect *a priori* that the layers of peroxide, formed upon the electrode by the working of the current itself, should be more regular, and yield currents with greater regularity, than the artificial and more rapidly-formed layers made by painting red lead upon the surface. On the other hand, M. Faure points out that, taking cells of equal size, a larger proportion of the weight in his cell consists of the working substance. The weight of red lead placed in his cells being, for equal amounts of surface, about 26 times as much as the weight of peroxide produced by a "formation" during two years on the plates of a Planté cell of equal size. If this be so, it would imply that, though its resistance might be greater, and its rate of working slower than the Planté cell, the Faure cell would accumulate twenty-six times as much energy in an equal space. These figures require yet to be confirmed, and they are hardly borne out by the statistics of M. Regnier. Still less do they justify the extravagant pretensions that have been ignorantly set up on behalf of the enormous powers of the Faure cell—pretensions which have been angrily combated, though it is well to note that neither M. Planté nor M. Faure have taken part in this unpleasant recrimination. The Faure cell will do what the Planté cell will not, take in a greater charge, because it has a greater thickness of the working material, and it gives up its charge less rapidly. The Planté cell will do what the Faure cell of equal weight or surface cannot do, namely, produce rapid discharges in currents of greater volume; a property invaluable for the purpose of some of the applications already named.

APPLICATION TO ELECTRIC LIGHTING BY INCANDESCENCE.

Faure's cells have already done good work in providing an efficient means of working incandescent lamps, such as those of Swan and Maxim, for domestic purposes. I have the pleasure of showing you to-night the result of passing through two chandeliers of Edison's little incandescent lamps, the current generated by forty of Faure's accumulators. Here are also some of the incandescent lamps of Swan and of Maxim, lit up by the same means. I have to thank the representatives of the various companies for the courtesy that has put at my disposal these means of illustrating my discourse.

Careful and precise measurements bave been made by Sir William Thomson and Mr. J. T. Bottomley, using from 20 to 70 Faure cells as a source of current to illuminate some of Swan's lamps. These measurements have shown that the efficiency is very considerable, and that where from 35 to 50 such cells are available, the light produced by one lamp may range from 300 to 400 candles per horse-power, the latter being measured as actually consumed in the lamp. The foregoing statistics of one series of experiments are taken from the paper read by Sir Wm. Thomson at the meeting of the British Association at York, September, 1881. From these experiments, it appears that a high degree of economy in lighting by incandescent lamps is really attained. Should the accumulator be further improved, to reduce the per-centage of waste between charging and discharging, accumulators will play a very important part in future installations, provided they can be constructed at a prime cost, lower than the present figures.

SWAN LAMP, NO. I.

No. of experiments.	Cells.	Volts.	Webers.	Volts × webers ÷ 10 ÷ kilogrammètres	Horse-power.	Candles.	Candles per horse-power.
1	26	56·9	1·21	6·88	·093	11·6	125
2	30	65·5	1·46	9·56	·129	25	194
3	32	70·2	1·64	11·51	·156	42	263
4	33	71·8	1·74	12·48	·170	38	224
5	34	74·1	1·81	13·42	·181	44	243
6	35	76·1	1·82	13·86	·187	55	294
7	36	78·0	1·99	15·52	·210	63	300
8	37	80·3	2·06	16·54	·224	66	295
9	38	81·9	2·06	16·88	·228	76	333
10	39	84·6	2·06	17·43	·235	82	349
11	40	87·0	2·10	18·27	·247	84	340
12	42	90·9	2·17	19·72	·267	102	382
13	44	92·0	2·11	19·96	·270	89	330
14	46	99·1	2·27	21·91	·296	114	385

Carbon of lamp broke with same power, immediately after the measurement of the light was completed.

At the Paris Exhibition of Electricity, Faure's batteries have been doing excellent work. The following details of the separate installations will give an idea how many cells are required for a given number of Swan's lamps:—

	Swan lights.	Faure cells.
Vestibule	23	56
Kitchen	4	
Bath-room	2	
Telephone Room (No. 7) ..	17	29
Telephone Room (No. 8) ..	18	29
Exhibit of the Compagnie La Force et La Lumières	34	56

FURTHER APPLICATIONS OF ACCUMULATORS.

In an article on electric storage, which appeared in *Nature* on June 2, 1881, I pointed out the usefulness of accumulators, in the following words:—

> "The uses for such secondary batteries may be of three kinds:—1. They may serve as portable supplies of electricity to be left and called for to recharge when exhausted. 2. They may serve to accumulate supplies of electricity from dynamo-electric machines, and store them until required for furnishing electric light or motive power on a small scale. 3. They may serve as equalisers of electric currents in a system in which the supply is liable to fluctuations. Suppose, for example, a dynamo-electric machine is employed to produce electric light. Any least thing which alters the speed of the machine, even for an instant, makes the light flicker and change in intensity; while the breakage of the engine-strap would at once cause total darkness. But if a secondary battery of suitable dimensions and power were inserted across the circuit between the dynamo-machine and the lamp, the inequalities of the current would be greatly modified. When the light was not in use, the battery would store up the current. If the engine failed, the battery would at once put forth its power. It is probably in this direction that the secondary battery will find no unimportant field of usefulness."

Of the first and second of these purposes you have an illustration to-night, this medical Planté cell and these forty Faure cells having been brought to this room charged, for the purpose of showing you their powers. The third possible use has been also emphasised by Sir William Thomson, who, at the September meeting of the British Association, gave details of a scheme of automatic adjustments to make and break the circuit between the dynamo machine and the secondary battery, so as to guard the former from damage and the latter from waste.

As to portability, for such purposes as domestic lighting the cost and risk of carting the heavy cells to and fro is probably prohibitory. For special purposes, such as those of galvano-cautery already mentioned, the Planté accumulator is certainly superior to the Faure, since it is lighter, and at the same time gives up its charge more rapidly, though its storage power for cells of equal bulk is less than that of the Faure.

MAXIMUM TEMPERATURE ATTAINABLE BY A CELL.

In connexion with the subject of obtaining a high temperature by means of a cell, it may not be out of place to point out that the very high electromotive force of these accumulators (about 2·2 volts), exceeding that of any single cell of any other kind, carries with it the possibility of obtaining with such a cell a lower electromotive force. This discovery is due to Lorenz, of Copenhagen, who, in a very remarkable paper published (in "Wiedemann's Annalen") in August last, upon the relation between the conducting power of metals for heat and for electricity, has shown that the highest possible temperature which a cell can raise any part of its circuit is proportional to its electromotive force. The highest point to which a Daniell's cell, however large, can raise a conductor is, according to Lorenz, 3,327° above the zero of the Centigrade scale. The limiting temperature for a Planté or a Faure cell is 6,927°.

APPLICATION TO BLASTING AND TORPEDO FIRING.

The great calorific power of these accumulators, due as much to their small internal resistance as to their high electromotive force, is doubtless of great importance in the application to the firing of torpedoes and blasts in mining. The special batteries now used might economically be replaced by one or two storage cells provided with a charging battery of half a dozen Daniell's cells, whose slowly-produced currents could be thus accumulated.

APPLICATION TO PERFECTION OF THE TELEPHONE.

Another application of the secondary batteries which has occurred to me, and which, on a small scale, I have tried with success, is in connexion with telephone transmitters. There is still room for improvement in the telephone; at its best the speech it transmits is neither so loud, nor so distinct, nor so free from extraneous sounds, as might be desired. The fault lies almost wholly with the transmitters. They will not transmit loud sounds distinctly. The strength of the currents generated by the Bell telephone, used as a transmitter, is limited by conditions which are wholly distinct from those which limit the possible strength of the currents transmitted by a "microphone," or "carbon transmitter;" my remarks mnst be understood as applying to the latter kind of instrument. If you put a very strong current on to a microphone, so as to make it, as you think, speak more loudly, the end is not attained. The points of contact get hot; there is a whirrring and wheezing heard at the receiving end; and the speech degenerates into confusion. There is then, a practical limit to which the strength of current flowing through a microphonic current can be carried. Some of the transmitters in use employ three or four points of contact, the current being carried through these either in series or in branching arcs. In the first of these two cases, the limitation is only pushed back by one stage. In the latter case, one only of the contacts usually does the real work of transmitting, namely, that whose resistance is least. I propose to increase the power of a transmitter, by employing a multiple microphone, so arranged that a fairly strong current shall pass through each point of contact, and that the current through each contact shall be independent of that through the rest. I therefore arrange all the individual microphones in parallel arc, in the line circuit, but provide each with its own battery. A hundred microphones thus united, and simultaneously acted upon by the voice, will each add their own quantum to the total effect in the circuit; and the result will be loud and distinct speech. But a hundred microphones so arranged, each with its own battery, implies two or three hundred cells. Here the secondary cell comes in with great advantage. I propose to use very small storage cells, each consisting of two small leaden plates, or wires, dipping into dilute sulphuric acid, and properly "formed." Two such cells may be connected with each microphone, and the whole, being already arranged in parallel arc in the circuit, can be kept charged by merely placing across the circuit six Daniell's cells, to be switched off when the transmitter is to be used, and switched on again when the transmitter is no longer required. As yet only a small and rough model of this "secondary circuit transmitter" has been made; but it is extremely satisfactory in its action, and promises to be the first of a useful and important application.

APPLICATION TO RAILWAY PURPOSES.

A proposition is now about to receive practical application to light a railway train with Swan's lamps, by means of Faure's accumulators. This is the new Pullman-car train, plying four times per diem between London and Brighton, which will be lit by forty Faure cells. The trial trip is to be arranged in a few days. A train might be contrived to store electricity gradually, by a dynamo-electric machine fixed to the axles of the carriages, and thus to have a supply of electricity, to be turned on when the train passes through a dark tunnel.

APPLICATION TO UTILISATION OF WIND AND WATER-POWER.

And, lastly, though by far the most important of all the innumerable possibilities opened out by the storage battery, is its application to the problem of utilising and transmitting the energy derived from wind or water-power. The difficulty of utilising water-power is that, that it is so often not to be found where it is desired; the difficulty with power is that it fails too often just when it is wanted. The reversibility of the dynamo-electric machine solves the difficulty of the where by giving us a means of electric transmission. The reversibility of the voltaic cell will probably solve the difficulty of the when, by giving us the means of storing energy, when we can get it, until such time as required for use. The accumulator will probably play an important part also in the distribution as well as in the storage of power transmitted from a distance, and thus become the ally of the dynamo-electric machine. It is certain that we cannot, with our diminishing coal-fields, long afford to neglect these other sources of natural power. In his Presidential Address to the Mathematical and Physical Section of the British Association, Sir W. Thomson has dealt with this question, and has come to the conclusion that, though tidal power be practically unlimited, it will not pay economically to build tide basins to utilise this power, as the reclaimed land would be of greater productive value, and that, therefore, we must not look to the tides. If I may venture modestly to differ from so great an authority, I would point out that there are cases where no great expense would be incurred in utilising natural tidal areas as basins, where the area so utilised could not possibly be reclaimed or worked as profitable land, and where the rise and fall of the tide is greatly above the figure which he assumed. The River Avon at Bristol furnishes a case in point. It requires but a few yards of embankment to be turned into an available tidal area. The average rise and fall of tide at the city of Bristol, five miles from its mouth, is 23 ft. According to calculations I have made from the average volume of water displaced up and down each tide, there are no fewer than 20 billions of foot-pounds of energy wasted every year, or enough to charge ten million Faure cells. At the mouth of the river the total annual tidal energy thus running to utter waste cannot be less than 50 billion foot-pounds; and in the rapid currents of the River Severn, with their enormous tides of great volume, the tidal energy must be practically unlimited. A tenth part of the tidal energy in the gorge of the Avon would light the city of Bristol. A tenth part of the tidal energy in the channel of the Severn would light every city, and another tenth would turn every loom and spindle and axle in Great Britain. But the power would have to be not only transformed and transmitted, but stored, to be available for such ends. Accumulators are therefore a necessary feature in any scheme to utilise the intermittent forces of the tides. Whether the present form will prove adequate to the purpose, the future must decide. Probably the present accumulator bears as much resemblance to the future accumulator, as a glass bell jar, used in chemical experiments for holding gas, does to the gasometer of a city gas works, or as James Watt's first model steam-engine does to the engines of an Atlantic steamer. When the practical accumulator of the future has been built, it will be more easy to say what will be the limit of its applications. There are, as I have sufficiently shown, immense possibilities in store. Electrical railways and electrical tramways are now existing facts Many months will not elapse—or it will be an eternal disgrace to the first city in the world —before the fœtid and poisonous atmosphere of the Metropolitan Railway is replaced by a pleasant and salubrious air, rich in fragrant ozone; and the like revolution will not be long delayed in many quarters where reform is far less imperative. In all these changes the accumulator will have its part to play. A reserve of electrical energy stored till wanted will be a necessary part of all systems for electric distribution, whether for the purpose of lighting, or for motive power.

In conclusion, I would point out how the invention of the accumulator for storing the energy of electric currents has arisen out of the study of an obscure and unpromising detail in the science of electricity—the phenomenon of so-called "polarisation." Regarded by most experimenters merely as a trivial but disturbing fact in the construction of voltaic batteries, to be put down or got rid of by whatever means, it has been developed, and, mainly by the long and patient researches of one man, M. Gaston Planté, and finally by the brilliant idea struck out by M. Faure, been turned into one of the most fertile and promising features in the development of the science. It is the old story over again of the reward which follows patient investigation of unexplored corners and waste places of science. Grand principles and sweeping generalisations are magnificent weapons to the scientific investigator. The principle of the conservation of energy has reaped triumph after triumph; and a kindred generalisation in the science of electricity is destined, as I think, to lead to scarcely less important results. But there are other ways of adding to the sum of human knowledge, beside the following out of grand sweeping principles. There are half-forgotten observations, unconnected, unexplained, and often exceptional in character, every one of which has a significance of its own—residual phenomena, every one of which is, to the scientific man, of a value beyond price. He who investigates them patiently, may find the clue to their meaning, and reap a rich reward from them. They are the finger-posts in the high road of scientific discovery.

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks to Professsor Thompson, said that gentleman had gone a long way back for the origin of secondary batteries, viz., nearly to the time of the invention of the voltaic battery itself; there was, however, a very interesting little book, which had been shown at the Paris Electrical Exhibition, a note-book of Galvani's, in which it was recorded that in 1795, *i.e.*, five years before the discovery of the voltaic pile, he had made an experiment, and discovered a secondary battery, and also made use of a galvanometer, which was not quite the same as that which Professor Thompson stated was used by Ritter. The primary battery which he employed was the electric eel, by means of which he gave a charge to the limbs of a frog, and then using the frog as a secondary battery, and himself as a galvanometer, he was able to get a secondary electric discharge. With regard to the vexed question of electromotive force, he was glad to see that there were figures put forward, though there had not been time to go into them, which confirmed the results arrived at by himself with regard to the amount of electromotive force of the Planté cell. The results arrived at by Sir William Thomson show that the electromotive force of the Planté cell lies between 2 and 2½ volts. The development of this subject had been very rapid indeed. Only a little more than four months ago the Faure battery was quite unknown in England; it was in fact shown for the first time in July, when he had the opportunity of showing it at King's College, through the kindness of Mr. Faure, and demonstrating how the electric light might be obtained by its means; but since then its development had been very rapid. With regard to the amount of work capable of being stored up, they had heard of millions and billions of units, which he feared would not convey a very definite idea to the general public; but perhaps the Electrical Congress of Paris had done a little in suggesting names for electrical units, and if instead of hearing of such enormous numbers of foot-pounds in connexion with electricity, they could get the work represented by so many "volt-coulombs," putting together the units of electromotive force and quantity, it would be simpler, and a better idea would be conveyed of what the unit really was.

Prof. ABEL, F.R.S., said he had been greatly interested and instructed by this very lucid paper; a more complete account of the very rapid development of this subject could not have been given in so short a space of time. He did not pretend to be a scientific electrician, though he dealt sometimes with the practical applications of electricity, and he had listened therefore with the greatest interest to what Professor Thompson had told them of the recent developments which the secondary battery had received, and was still receiving. As he listened to him, he began to feel sanguine that these applications might be realised. There were some directions in which, if they could obtain a moderately portable battery, which could be re-charged in a reasonable time, he could see applications that would be of the highest importance. He alluded to the illumination of coal mines, a matter in which he was particularly interested; and he did begin to hope that they might before very long realise the sanguine expectations of some philosophers, and that electricity would be used for this purpose. Up to quite recently, he had been very doubtful, for, having seen some of the first attempts, he had had reason to fear that the necessity for conducting wires along the workings, and in places liable to great falls of the roof and various kinds of accident, might lead to injuries, not merely fatal to the illumination, but also, possibly, to the lives of the miners, in consequence of the production of sparks which might ignite the inflammable gases. If, however, they could see their way to transport to the furthermost parts of the mine a convenient form of secondary battery, with which they could work readily with only short lengths of wire, and if small portable lamps could be attached to the men's caps, there would be accomplished what might be considered the most perfect and safe illumination of a mine possible. This he hoped would be done before many years; there were, no doubt, many other directions in which the stored-up energy might be very advantageously used.

Prof. FRANKLAND, F.R.S., said this invention of the storage of electricity was most important in connexion with the applications of this force which were being made at the present time. It was a reproach, not altogether unfounded, against the dynamo-current as ordinarily produced, that it might, at any moment, fail from the accidents of machinery or other causes; but such failures would be entirely obviated by the aid of a suitable and effective storage battery, of the kind invented by Planté or Faure. He should like to ask Professor Thompson whether, in his numerous experiments on this subject, he had gone at all into the subject of the length of time this force could be kept stored up in the battery. This was an important point, which, he feared, had been a good deal neglected hitherto. He should like to know whether there was any considerable amount of leakage, and, if so, how much, and for what length of time a battery might be expected to retain its charge. He could only conclude by expressing his best thanks for the very able lecture Professor Thomson had given.

Mr. EVANS asked if a number of Faure accumulators could be used to store up the power derived from water-wheels, so that the wheels of turbines might work during the night, and the power thus stored be used during the day.

Mr. SHOOLBRED wished to add a word or two in regard to the De Méritens' battery. He had lately returned from a visit to Paris, and he found the form in which De Méritens was now making his battery, in a practical way differed considerably from the form in which they first appeared, and which had been shown on the screen. Each cell consisted of a solid lead, filled in with thin sheets of lead, less than a millimetre in thickness. It was much simpler than either the Faure or the original Planté battery; whether it was as efficient, yet remained to be seen; but the one in the exhibition worked very well. M. De Méritens had informed him that it took from fifteen to twenty days to form the cell, not, as he had understood Dr. Thompson to say, six months. He had hoped to have got one to bring over, but could not do so. With regard to the figures in the table (see p. 33), and which he saw were Sir William Thomson's, he wished to say that, by the kindness of Sir William Thomson he was enabled to repeat the experiments for photometric measurements, with the aid of Mr. Keats, of the Metropolitan Board of Works, who kindly brought over his own photometer, and the candle power came out even higher than as given by Sir William Thomson.

The SECRETARY said he was happy to announce that he had seen M. De Méritens very recently in Paris, and he promised that he would send over a complete set of his batteries to the Society of Arts, as soon as they were ready in January or February next.

Two further questions having been asked, viz., as to the expense of producing the light, and why the electric energy in the secondary battery was not given off all at once,

The CHAIRMAN put the vote of thanks to the meeting, when it was carried unanimously.

Prof. THOMSON having acknowledged the compliment, said he would answer the last question first, and he might do so by asking another. How was it that a voltaic battery gave off its energy gradually, instead of going off with a bang? You could not get zinc to dissolve at more than a certain rate; nor in the case of the stored battery could you get the peroxide to reduce itself, and the reduced lead to oxidize itself, at more than a certain rate. Besides, if by any possibility, the battery did go on at too great a rate, it would polarise itself—it would begin to reduce the side towards which the current was going, and so bring down the amount of current passing. The rate at which the action went on depended on the conducting power of the lead, its resistance to electricity, and the amount of surface exposed; also on the condition of the deposited substances. A piece of coal did not give up its energy all at once, when put into the fire. As a matter of fact, the action at the surface did not go on at more than a certain rate. As to the expense, he should not like to give figures which he could not stand by in a court of justice, and therefore he would not give any. At the same time he should like to explain that he believed the expense of the light then shown would be less, considerably, than it would cost to produce the same amount of light by making gas. For a steam-engine with the necessary plant to work a small dynamo-machine, and the necessary accumulators to store it up sufficiently to give out for four or five hours a light like they saw before them, would certainly not cost as much as to have to set up a gas generating apparatus with a small gasometer, and the pipes to produce gas of equivalent value. When the prime cost was less to begin with, he had simply to consider the cost of maintenance; and he was quite certain that the gas put into a gas-engine to work a dynamo-machine would produce more light electrically than it would if burned directly. There was now no question on that score. With regard to the water-wheels, if they were used to work a dynamo-machine for fourteen hours, and during those fourteen hours the electricity were stored up in an accumulator, or a set of accumulators, it would be a much cheaper and better way of obtaining and storing electricity for lighting, or any other useful purpose, than setting up a large dynamo-machine to produce the light directly. For instance, in the Savoy Theatre they had a large number of lights produced directly from dynamo-machines driven by steam-engines, and the lights, when they were all on, flickered up and down, on account of inequalities in the driving. If they employed 1-5th or 1-6th of the driving power, and worked the engines all day into accumulators in the cellars, he believed they could work the lights not only far more steadily, but far more economically. He had been asked by Professor Frankland what waste there was by lapse of time in these accumulators, and he had made some inquiries that morning as to what happened on a practical scale, and he was told by Major Seaver that he reckoned there was about 10 per cent. per week loss from batteries left idle. As a fact, they really did not yet know the conditions under which the leakage took place, whether by surface conductivity, by electrical convection, or what. There was a certain amount of waste, but, neverthelesss, there were cases in which a very considerable amount of the charge had remained for a considerable time. For instance, there was the celebrated box which was sent from Paris to Sir William Thomson, containing four small cells rolled up in spirals, and packed together. When they went to Glasgow, they contained the million foot-pounds; they had been partly discharged again and again, and yet they would still work a small lamp, and would give light for many hours, probably. Then some of the Planté cells would retain their charge for a long time. The medical cell he had shown them was brought from Dublin by Professor Barrett a short time ago. He had used it in Dublin. It was then sent to him at Bristol, where it was used, and then it came there, and there was a considerable amount of force in it yet, though, unfortunately, in an evil moment they broke the glass, and half the liquid ran out. The Planté cell held its charge a long time, and he did not see why the Faure should not be equally successful. With regard to the De Méritens battery, he did not mean to be taken literally when he said it took some six months to get the cells into a working state, but he did think it was a step backwards to use Planté's method of long continued electrical action, instead of Faure's more rapid process of producing the peroxide from red lead. He must conclude by expressing his thanks to those who had so kindly assisted him by lending apparatus for the purpose of the lecture.

During part of the evening the room was lighted by a number of Edison lamps, worked by Faure batteries lent by the Société de Force et de Lumière. Incandescent lamps by Swan and Maxim were also shown at work.

Miscellaneous.

REPORT ON PHOTOMETRIC STANDARDS.

The Committee on Photometric Standards was appointed by the Board of Trade to examine and report upon the different standards which have been proposed by Mr. A. G. Vernon Harcourt, by Messrs. T. W. Keates and W. Sugg, and by Mr. J. Methven, and also upon the standard which is now used for testing the illuminating power of coal-gas. It was shown, by preliminary experiments, that standard candles are not uniform in their illuminating power; the causes and range of their variations were therefore experimented upon. In 115 determinations, a maximum variation of 22·7 per cent. in illuminating power was found between two pairs of candles; all these experiments were made by one observer, working with one apparatus, and as uniformly as possible.

The lamp devised by Messrs Keates and Sugg is intended to give the light of 16 standard candles, when burning pure sperm oil with a two-inch flame from a circular wick. As a rule, the light emitted was constant, but occasionally it was subject to sudden variations; therefore the Committee think that it falls short of the requirements of a standard of light.

Mr. Methven's system is exceedingly simple, but still it is not considered by the Committee to be sufficiently exact for the work required of it. The system consists in allowing only a particular part of a three-inch coal-gas flame to pass to the photometer, the coal-gas used at the testing burner being the same as that tested.

With regard to Mr. Harcourt's standard air-gas flame, the Committee say it is exact and trustworthy, as compared with the sperm candle. The extreme difference obtained by two observers, in 19 different observations, by Mr. Harcourt's method, was 0·3 candle, or 1·8 per cent. They recommend that in official documents the light furnished by coal-gas should still be expressed in standard candles, and also that the use of the sperm candle should be discontinued, and for the future Mr. Harcourt's air-gas flame (as defined in the appendix to the report) should be employed instead.

The number of grains of sperm burnt per hour in a standard candle has undergone many alterations, and has been the subject of many discussions. In 1849, the Great Central Gas Consumers' Company decided upon 131·5 grs. per hour. In 1852, Prof. Graham and Dr. Leeson recommended that this should be changed to 140 grs. In 1860, the standard consumption of sperm was fixed at 120 grs. per hour; this is the present standard. It is here stated that only two London firms at present make sperm candles of the kind prescribed by the Acts, namely Messrs. Langton and Bicknell, of Newington-butts, and Mr. T. G. Miller, of Westminster. Mr. Miller states in a letter written to the Committee that, in his opinion, the irregularity with which the candles burn is due to irregularity in the plaiting of the wick.

The Committee have made a large number of experiments on the consumption of sperm by candles having different wicks, having from 18 to 23 threads in them. The results of four comparisons between candles from different packets of Miller's 21-thread candles, each comparison being the mean of 20 observations at intervals of one minute, show that the ratio between the illuminating power of two pairs of candles frequently alters by 6 or 7 per cent. in less than one minute. In six instances the ratio altered more than 10 per cent. within a minute.

The Committee find that candles are open to very grave objections when used as a standard source of light. They mention very aptly that, beyond the custom of candle makers, there is nothing in the Parliamentary definition of the present standard candle to limit the diameter of the candle.

The following is a description of Mr. Methven's standard burner, which consists of a Sugg's London Argand, burning coal-gas with a 3-inch flame, having in front a screen with a slit cut in it:—

"In front of the burner, between it and the photometer disc, is fixed a brass screen, with provision similar to that of an ordinary candle holder, for fixing it at the end of the photometer bar. The tube on which the burner is fixed is provided with a T-piece and union joint, to which can be attached a flexible tube from the ordinary service to the photometer, supplied with an ordinary micrometer cock and governor, to facilitate the adjustment of the height of the flame. The end of the tube is fixed on a stand, so that the whole may be lifted off the end of the bar at any time. A hole, about one inch in height, and one-quarter of an inch in width, is cut in the screen, which will be found sufficient to allow an amount of light to pass through it equal in illuminating power to that given by two standard sperm candles." The principle of Mr. Methven's standard depends on the possibility of finding corresponding portions of the flames of gases, of varying qualities, consumed so as to effect perfect combustion in similar burners, which shall be equal in illuminating power.

Experiments were made with different gases, such as pure Cannel gas, and Cannel diluted with varying quantities of common gas. The result of these experiments, showed that while the light from the 37 candle gas was nearly equal to that from the 16½ candle gas, with intermediate qualities of gas, the burner gave more light, the slit being in the same position throughout.

Mr. Vernon Harcourt's standard air-gas flame is produced by burning a mixture of air with that portion of American petroleum which, after repeated rectification, distils at a temperature of about 50° C. It is almost entirely composed of pentane; the proportion used is 576 volumes of air to one of pentane, measuring the liquid at 60° F.; the diameter of the burner is a quarter of an inch, and the height of the flame is brought to 2½ inches. Several experiments on illuminated power were tried with samples af air-gas made on different days, and the results were found to be very concordant, the greatest difference between two observers being 0·2 of a candle. Other experiments were tried, to find the effect of making a too rich or a too poor air-gas, and it was found that, taking the illuminating power of the normal mixture to be 100 candles, if 2·0 cubic feet of air were taken instead of 3, the illuminating power was equal to 100·53 candles, and if 3·1 cubic feet of air were taken to the same quantity of pentane, the light emitted was equal to 99·65 candles. The error in the volume of air being at least ten times greater than that likely to be made by any operator, it will be seen that the light will not be subject to much variation in intensity. All the experiments made with the air-gas flame being very satisfactory, the Committee have judged it to be the best standard for comparison.

It may be added to the above Report of the Committee, that Mr. Harcourt devoted special attention to Photometry in his fourth Cantor Lecture on "The Chemistry of Gas Manufacture," *Journal of the Society of Arts*, vol. xxv, p. 841, and that he there explained the principle of his proposed standard.

OLIVE CULTIVATION IN ITALY.

Mr. Schuyler Crosby, the United States Consul at Florence, states that the greatest care and attention has been for years bestowed on the olive tree, and great efforts made to make it yield, when young, the expenses of its cultivation, and every known means to effect this result have been tried without success. Calculations, from year to year, of the cost of planting, value of land, expenses of cultivation, gathering the berry, &c., made by the most experienced and enthusiastic of farmers in Italy, show conclusively that, even under the most auspicious circumstances of climate and weather, the tree does not yield a profit to the grower, under thirty and sometimes forty years. In Tuscany, an old proverb runs thus: "The chestnut trees of my grandfather, my father's olives, and my own vines." Hill sides, with a southern exposure, are almost always chosen for planting, either from the seed, branches, or the roots. Along the Mediterranean the olive tree does not thrive well when planted on the plain, and at a certain distance from the sea suffers much from a saline deposit on its leaves, which, if not washed off, by a timely shower, renders the tree for a long time unproductive. The tree is an evergreen, retaining its foliage at all seasons of the year. It dreads damp air, and thrives best in fresh earth, which retains a certain amount of humidity, and does not become arid; for this reason, calcareous soil, which does not undergo either extreme of climate, is the best adapted to its cultivation; it flourishes even in the cavities of the stoniest hills and mountains, and its roots will thread the smallest crevices of a rocky hill-side. To this quality of earth or soil is attributed the wonderful prosperity of the olive tree in certain parts of the Pisan and Lucchese territories, where it is absolutely planted in the calcareous rock, which being cavernous and spongy, retains just sufficient humidity to nourish, and not injure the roots. It is said that the olive tree never dies, and that the most neglected and withered plants, with no earth to be seen round its roots, and showing no signs of vitality, may, by means of abundant manuring, by filling in earth round the roots, or by transplanting the roots into new ground, be reclaimed, and again made productive. The berries are generally gathered in November, just before they become ripe, and when a grape-coloured tint appears upon the surface; though some growers insist upon the advantage of permitting the crop to remain on the tree until January or February; the objection to this delay, however, is that the fruit gathered so late in the season, not only produces an inferior quality of oil, but also seriously damages the prospects of the next year's crop. The berries are gathered as far as possible by hand, the peasants using ladders which will reach the highest points of the tree, great care being taken not to strike or even shake the limbs—shocks being hurtful to the tree, and are apt to seriously injure the young and tender branches' which are precisely those which will bear the next year's fruit. After the olives are gathered, they are carefully placed on wooden racks in order to let them lose a certain amount of humidity, and constantly moved about to keep them well ventilated and prevent fermentation. In extracting the oil, great care must be exercised in the pressing of the olive, which must be gradual and slow; for, if done with too much haste, as is often the case when steam is employed, the oil is sensibly deteriorated. If an oil of a very superior quality is required, great care is always taken not to crush the stone, or even to bruise it. The process of extraction varies according to the quality sought to be obtained, whether for the table, for burning, or for industrial purposes. The oil expressed from the fruity portion of the olive, when obtained by gentle pressure, and without the agency of heat, is called virgin oil; it is an exceedingly thin liquid, translucent, unctuous to the touch, and of a colour that varies between a faintly greenish and amber tint; its taste is sweet and pleasant, and it has a slight olive odour; when of only recent preparation, it is somewhat turbid, but after a short repose, it becomes transparent, and deposits a blackish sort of dreg, composed of the fatty principle of oil, mucilage, and azote. Next, after virgin oil, the result of cold and gentle pressure, and which always retains the taste of the fruit from which it is expressed, and which serves as a condiment for food, and as a preservative of commestibles, such as the olive itself, the tunny fish, sardines, &c., come other qualities known as ordinary oil, lamp oil, and lastly "olio d'inferno," used for machinery and industrial purposes, and probably so-called from the amount of heat and torture it has been subjected to in the process of manufacture. The ordinary oil is made from the second application of the screw, when the pressure is brought to bear upon stones, kernel, and every part of the berry; even boiling water being used as an agent to assist in the increase of the yield of oil. When the mass of paste refuses to yield any more oily matter to the press, it is placed in large troughs of clean water, and kept moving as long as it furnishes a single drop of oil. This pasty mass, called "sanza," is then moulded into blocks, and set apart to dry, when it is much sought after for fuel for manufacturing purposes. Thus, from the moment the fruit is consigned to the press-room to the end of the process of extracting the oil—even to the feeding of the furnaces of the workshops—not a single particle of the olive has been allowed to go to waste. The process of clarification of the oil is effected naturally, by letting it stand for a certain time, during which the substances held in suspense are gradually deposited at the bottom of the receptacle. The oil is first placed in wide, low vases of earthenware, thickly glazed, and allowed to remain four or five days, after which the contents are drawn off, leaving the deposit behind. The more frequently the oil is separated from the deposit, the finer will be the quality. The oil, however, frequently holds these substances for a long time in suspension, when it becomes necessary to have recourse to filtration, in order to accelerate the depuration and clarification. The filters used in Italy, and also in France, are formed of heavy vats, with a double bottom, which is perforated with conical-shaped holes, forming so many funnels, into which pieces of clean carded cotton are lightly placed. For the first few days the oil passes perfectly limpid through the cotton, and then, on account of the choking of the funnel, ceases to flow. Several layers of clean straw are then laid at the bottom of the vat, and these are sprinkled with well-washed animal charcoal, in rather coarse grains; in this case, the charcoal deprives the oil, during the passage, of a certain amount of impurity, while the renewed clean cotton in the funnels does its work so well, that the oil reassumes its wonted clearness. It is then put up in kegs and barrels, and is ready for home consumption, or exportation.

Correspondence.

BOILERS OF KITCHENERS.

"F. B. W." asks for a remedy for the danger of explosion of kitchen boilers. Last winter I wrote a letter on this subject, which was, I think, printed by all, or nearly all, newspapers in Great Britain, and was also copied into several foreign papers, and it would appear strange that "F. B. W." has overlooked this. The simplest, safest, and cheapest way is to take them out, doing the same work, as required, with gas. This is what we have done for the last two years, with very decided advantage and economy.

If the boilers are left in use, cut a hole in the hot-water (ascending) pipe, say $\frac{1}{4}$ inch in diameter, and solder over this a bit of very thin sheet lead, just sufficient to stand the pressure of the head of water in the pipes. This must be placed within reach of the direct heat of the fire, so that the pipe cannot be frozen up near it, and it must also be so placed that, if the sheet lead bursts, the water is not thrown into the kitchen. The sheet lead need not be soldered on, it will be found quite sufficient, if the pipe is dry, to stick it on with white lead, or pitch, and to tie it on with copper wire, the wire not to pass over the hole in the pipe. This is a simple and cheap safety-valve which can never stick or get out of order; it is a weak place in the system, which will be first to give way.

Some manufacturers have commenced to make small screwed caps with a hole through, covered with thin sheet lead, which can be fixed either in the boiler, or in the pipe, as most convenient; and no doubt these can now be readily obtained from, or through, any plumber.

THOS. FLETCHER.

Museum-street, Warrington.

Obituary.

BENEDETTO ALBANO was born in the kingdom of Naples, about the year 1796. He was placed in the Royal Polytechnic School at Naples, where he distinguished himself in mathematics. Subsequently, being suspected of constitutional tendencies by the restored Bourbon dynasty, he had to flee for his life. Having fled to England, he was well received, and he entered the workshops and offices of Messrs. Rennie. He was employed on their London-bridge works, of which he afterwards published a plate. Besides joining the Institution of Civil Engineers, in the Society of Arts he found a valuable school of applied science, and took an active part in the work of the Mechanical Committee. He was employed by the King of Naples on the establishment of a railway system, and endeavoured, in conjunction with Mr. Hyde Clarke, to make financial arrangements with the Messrs. Rothschild, but a monetary crisis prevented the issue of the capital. The plan of Mr. Albano has, however, been mainly carried out in the existing railways. His friends in the English Ministry employed him to repair the Embassy House at Paris, and to construct that at Madrid. He undertook the task of converting the old Covent-garden Theatre into an Opera House. Much of the foundation proved to be rotten, and the walls had to be underpinned. Many of the plans were made by Mr. Albano in the theatre, where he was almost day and night.

Notes on Books.

SCIENCE FOR ALL. Edited by Robert Brown, M.A., Ph.D., F.L.S., F.R.G.S. Vol. 4. (London: Cassell, Petter, Galpin, and Co.)

The editor of this work continues to find subjects of every day interest to fill his successive volumes. Astronomy, Physics, Chemistry, and Biology are all well represented. The following articles are those which chiefly bear upon the points of applied science cultivated by the Society of Arts. "A Clod of Clay," by Mr. F. W. Rudler, which contains an account of various potteries; "A Piece of Paraffin," by Mr. J. Hunter; "Fogs and Fog Signals," and "How Buildings are Protected against Lightning," by Dr. Mann; "Coal Gas," by Mr. Falconer King; "Silkworm Disease," by Mr. A. B. Farn; "Heat Power," by Mr. Scott Moncrieff; "The Photophone," by Mr. W. Ackroyd; "Flint," by Professor Barff; and "Optics of a Lighthouse," by Mr. H. Trueman Wood. All the articles are fully illustrated.

SERIES OF CHRISTMAS CARDS. Published by Hildesheimer and Faulkner, 41, Jewin-street, London, E.C.

These cards are decorated with a large variety of fresh subjects, consisting of figures of animals, flowers, and fruit, and mention may be particularly made of the baskets of flowers and ferns, the groups of china and flowers in the Japanese style, and the cards in the form of round plates. Many of these are from original designs by Mrs. M. S. Duffield, Miss Kate Sadler, Miss Eleanor Manby, and Messrs. H. H. Couldroy, Charles Gregory, A. Ludovici, A. Ludovici, jun., and J. C. Wassermann.

MODERN ALPHABETS DESIGNED BY MARTIN GERLACH. (London: A. Fischer.) 1881.

We have here a series of seven alphabets designed with elaborate surroundings, and also vignettes of ornaments to match with them. They are all of the Gothic character, and have been elegantly printed, some at Leipsic and some at Vienna.

General Notes.

Synchronized Clocks.—A paper on "The System of Synchronizing Clocks adopted in London and elsewhere," was read by Mr. John A. Lund at the first ordinary meeting of the Society of Telegraph Engineers—an abstract of which is given in the *Times*. The system was adopted with the view to insure uniformity of time between public and private clocks generally; and by the synchronizing arrangement he had produced, Mr. Lund claimed that all practical demands for that purpose were met. The attention of electricians in the early days of their science was, he stated, as much devoted to synchronizing clocks as to message telegraphy, but the repeated failures in the former field as contrasted with the triumphant successes of the latter caused the application of electricity to telegraphy to become the favourite path of the electrician. Electric clocks were capable of being divided into six kinds. None of the old forms of electric clocks obtained a general public acceptance, the most successful, the Wheatstone, having only worked some five or six clocks from one motor. Their failure was due to the desire of making the clock subservient to the system, instead of *vice versa*. The criteria of a successful system of synchronizing, to obtain the approbation of the public while receiving the sanction of science, were that each clock should have a vitality distinctly independent of the time signal, and not stop through a failure of the regulating electric current to reach it; universal application to all kinds of existing clocks; lastly, due provision for the correction of errors. The system exhibited satisfied these conditions. Mr. Lund proceeded to say that, however perfect the mode of synchronizing might be, it could not be successful without a complete "system." The system consisted of a correct standard clock, which, assisted by a well-erected and well-maintained system of telegraph wires, should send out the needed signals to the synchronizers. Two "standards" were used (one to fall in automatically should the other fail) for transmitting the currents of electricity, and those standards received their motion from a standard clock. The applicability of time current wires for telephone purposes (except when the time current was in actual course of transmission) was shown by telephones being placed at each end of a circuit between the lecture-room (Institution of Civil Engineers) and Messrs. Barraud and Lund's establishment, Pall-mall, upon which wire there were also 12 electric clock synchronizers, through which conversation was carried on.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings at Eight o'clock. For evenings before Christmas:—

November 30.—"The Distribution of Time by a System of Pneumatic Clocks." By J. A. Berly. Lord Alfred S. Churchill will preside.

December 7.—"The American System of Heating Towns by Steam." By Capt. Douglas Galton, C.B., F.R.S.

December 14.—"Electric Lighting at the Paris Exhibition." By W. H. Preece, F.R.S.

For Meetings after Christmas:—

"Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. Burton.

"Stained Glass Windows." By Lewis Foreman Day.

"Photometric Standards." By Harold Dixon.

"Telephonic Communication." By Lieut.-Col. C. E. Webber.

"The Causes and Remedies of Bad Trade." By Walter R. Browne, M.A.

"The Native Tribes of the Hudson's Bay Territories." By Dr. Rae, F.R.S.

"The Manufacture of Ordnance." By Colonel Maitland.

"Some Practical Aspects of Recent Investigations in Nitrification." By R. Warington.

"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. Emerson Dowson.

"Gas for Lighthouses." (Illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses.) By John R. Wigham.

"The Relation of Botanical Science to Ornamental Art." By F. Edward Hulme, F.L.S., F.S.A.

"The High-pressure Steam-engine." By Loftus Perkins.

"The Industrial Resources of Ireland." By G. Phillips Bevan.

"A New Antiseptic Compound, and its Application to the Preservation of Food." By Prof. Barff, M.A.

"Tonnage Measurement." By Admiral Sir R. Spencer Robinson, K.C.B., F.R.S.

"Tools and Cutting Edges." By D. A. Aird.

"The Teaching of Forestry." By Colonel G. F. Pearson.

"The Art of Turning." By P. W. Hasluck.

"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By J. L. W. Thudichum., M.D.

"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. Thomas, F.C.S., and Percy C. Gilchrist, F.C.S.

"Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By WILLIAM COCHRAN.

"Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. HENRY NOEL SHORE.

FOREIGN AND COLONIAL SECTION.

The Meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 31; February 28; March 21; April 4, 25; May 23.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The Meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 26; February 23; March 9, 23; April 27; May 11.

INDIAN SECTION.

The Meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 17; March 17, 31; April 21; May 12, 26.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The First Course, on "Some of the Industrial Uses of the Calcium Compounds." Four Lectures, by THOMAS BOLAS, F.C.S.

LECTURE II.—NOVEMBER 28.

Lime. The calcination of the carbonate in theory and practice. Influence of foreign bodies on the quality of the lime. Most favourable conditions for the decomposition of pure and impure form of calcium carbonate. Cements and their uses. Lime as a refractory material. Lime-light. The oxyhydrogen furnace. Lime moulds for the casting of iron and steel. Notes on a few of the industrial and economic uses of lime.

LECTURE III.—DECEMBER 5.

Sulphate of lime and its occurrence in nature. Gypsum and alabaster. Plaster of Paris, its preparations and uses. Physical and chemical aspects of the setting of plaster. Accelerating and retarding influences. Scientific principles involved in some of the applications of plaster. Moulding, stereotyping, and other processes.

LECTURE IV.—DECEMBER 12.

Other calcium compounds and their uses. The phosphorescent sulphide. Lime soaps. Bleaching powder. Phosphates of calcium. Organic calcium salts. The hardness of water, &c.

JUVENILE LECTURES.

The two Juvenile Lectures will be by W. H. PREECE, F.R.S., on "Recent Wonders of Electricity." The dates for these are Wednesday evenings, December 28 and January 3. The lectures will commence at 7 o'clock. Special tickets will be issued for these lectures.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "Some of the Industrial Uses of the Calcium Compounds." (Lecture II.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. C. Hore, "Three Years' Observations on Lake Tanganyika."

Institution of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. J. D. M. G. McKenzie, "The Transformation of Annuities and Annuity Values, payable yearly into the like, when payable in fractional intervals, of a yearly means of constant factors."

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, Nov. 29....National Indian Association, (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m., Colonel R. M. Macdonald, "Home Education for Indian Ladies."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Henry Joseph Butler's Paper, "Forces and Strains of Recoil in the Elastic Field-Gun Carriage."

Zoological, 11, Hanover-square, W., 8½ p.m. Dr. A. B. Meyer, "On a New Species of *Eclectus* from Timorlaut Islands." 2. Mr. R. Bowdler Sharpe, "Note on the Genera *Schœnicola* and *Catriscus.*" 3. Mr. G. A. Boulenger, "Description of a New Species of *Anolis* from Yucatan." 4. Mr. W. A. Forbes, "Observations on the Incubation of the Indian Python (*Python molurus*), with special regard to the alleged increase of temperature during that process."

WEDNESDAY, Nov. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m., "The Distribution of Time by a System of Pneumatic Clocks," by J. A. Berly.

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

THURSDAY, DEC. 1...Royal, Burlington-house, W., 4 p.m. Annual Meeting.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Prof. Owen, "On the Homology of the Conario-hypophysial Tract; or the so-called Pineal and Pituitary Glands." 2. Dr. Maxwell Masters, "Note on the Foliation of *Buddleia auriculata.*" 3. Sir John Lubbock, Bart., "Experiments on *Daphnia.*" 4. Rev. G. Henslow, "Note on a Proliferous Double Mignonette." 5. R. MacLachlan, "On the Neuroptera of Madeira and the Canary Islands."

Chemical, Burlington-house, W., 8 p.m.

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

FRIDAY, DEC. 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discussion on the Society of Arts' Patent Bill. The Discussion will be opened by Sir Frederick J. Bramwell, F.R.S.

Geologists' Association, University College, W.C. 8 p.m.

Philological, University College, W.C., 8 p.m.

Journal of the Society of Arts.

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FRIDAY, DECEMBER 2, 1881.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the first course, "On some of the Industrial Uses of the Calcium Compounds," was delivered by Mr. THOMAS BOLAS, F.C.S., on Monday evening, 28th inst. The subjects treated of in the lecture were the calcination of carbonate of lime in theory and practice; the influence of foreign bodies on the quality of the lime; cements and their uses; the lime-light; and the oxyhydrogen furnace. Lime-moulds for the casting of iron and steel were shown, and the lecture concluded with some notes on a few of the industrial and economic uses of lime.

FOREIGN AND COLONIAL SECTION COMMITTEE.

A meeting of this Committee was held on Wednesday, 30th ult., to arrange for the proceedings of the Section during the coming Session. Present:—Mr. Hyde Clarke (in the chair), Dr. Badger, Mr. Pfoundes, Mr. Trelawney Saunders, Mr. J. A. Youle, with Mr. H. Trueman Wood, Secretary, and Dr. R. J. Mann, Secretary of the Section.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, 30th of November, 1881; Lord ALFRED S. CHURCHILL, Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ashford, Charles Arthur, 76, Upper-street, Islington, N.
Bennett, Charles Thomas, Bristol.
Buckney, Thomas, 61, Strand, W.C.
Catherwood, William Bailey, 87, Gower-street, W.C.
McHardy, Captain Alexander Burness, R.E., 8, Gloucester-street, S.W.
Moulton, John Fletcher, F.R.S., 11, King's Bench-walk, Temple, E.C.
Parkinson, Gilderdale John, 307, Moseley-road, Birmingham.
Pillow, Edward, A.M.I.C.E., 162, Wistaston-road, Crewe.
Sale, Major Matthew Townsend, R.E., C.M.G., 27A, Old Bond-street, W.
Saxby, John, Canterbury-road, Kilburn, N.W.
Stephens, George, 20, York-road, Leamington-park, Acton, W.
Thwaite, Benjamin Howarth, F.C.S., Bolton, Lancashire.
Vibert, Arthur Reginald, 7, South-square, Gray's-inn, W.C.
Wallis, Charles, Sister-house, Clapham-common, S.W.

The following candidates were elected as members of the Society:—

Arbib, Enrico, 5, Craven-hill, Hyde-park, W.
Bell, Sir F. Dillon, 7, Westminster-chambers, S.W.
Bowes, John, Ph.D., F.R.G.S., Warrington.
Cafferata, Redmond Parker, Newark-upon-Trent.
Carey, Richard, Camperdown-house, Snow's-fields, S.E., and New Western-street, Bermondsey, S.E.
Cassels, Herbert Wentworth, 51, Cleveland-sq., W.
Cater, John James, 39, Lombard-street, E.C., and Liston-house, Wimbledon, Surrey.
Chadwick, John, Vale-house, Greaves-street, Oldham.
Chalmers, John Reid, 7, Noel-street, Islington, N.
Chegwyn, Joseph T. W., Elm-lodge School, Streatham, S.W.
Child, Rev. Alfred, M.A., Therapia, Branksome-park, Bournemouth.
Church, George Frederick, 5, Wilmington-square, E.C.
City and Guilds of London Institute (Director and Secretary), Gresham College, E.C.
Clark, Henry, Gas Light and Coke Company, Great Cambridge-street, Hackney-road, E.
Cripps, Samuel George, Orsett College, Essex.
Crompton, R. E., Mansion House-buildings, E.C.
Dalman, Tomas José, 10, Rambla Canaletas, Barcelona.
Davison, Major Thomas, 16th Lancers, York.
Deane, Major George, Junior United Service Club, S.W., and 56, Warwick-road, Maida-hill, W.
Downes, Commissary-General, 28, Charleville-road, West Kensington, S.W.
Eastick, John Joseph, F.C.S., 15, Trinity-square, E.C.
Elkington, Leigh H., F.C.A., 71, Francis-road, Edgbaston, Birmingham.
Elmore, William, 91, Blackfriars-road, S.E.
Francis, Gerald Beaufoy, 31, Craven-street, Strand, W.C.

Fraser, Alexander Colvin, Gas Offices, Bolton.
Griffith, Frederick, A.M.I.C.E., 43D, Regent-street, Leicester.
Halkett, Ralph, Gas Works, Bicester.
Hallett, William Henry, F.L.S. (Mayor of Brighton), 141, Marine-parade, Brighton.
Hiddingh, Michael, F.C.S., Newlands, Cape of Good Hope.
Hill, Joseph, 97, Larkhall-rise, Clapham, S.W., and Crown Works, South Lambeth, S.W.
Hutchinson, Charles Henry, Church-street, Barnsley.
Inglis, John, 14, Praya Central, Hong Kong.
Izat, Alexander, A.M.I.C.E., Lenzie, near Glasgow.
Jessop, Maurice Ernest, 18, Elgin-crescent, Notting-hill, W.
Justice, Philip M., 14, Southampton-buildings, Chancery-lane, W.C.
Kirby, Edmund A., M.D., Kelsey-park, Beckenham, Kent.
Klenk, J. M., Sunnyside, Clapham-common, S.W.
Labouchere, James, 23, Chapel-street, Belgrave-square, S.W.
Lee, John Dunkin, The Oaks, Belvedere-park, Kent.
Lee, William, Downside, Leatherhead, Surrey, and 110, Cannon-street, E.C.
Lloyd, Richard, 2, Addison-crescent, Addison-road, Kensington, W.
Lloyd, William Henry, Hall-green, Wednesbury.
Lomas, Thomas George, the Hollies, Wellington-road, Whalley-range, Manchester.
Maclean, J. M., Malabar-villa, Grove-park, Chiswick.
Manton, Henry John, Northfield, near Birmingham.
Martin, Henry Austin, M.D., Boston, United States, America.
Melles, Joseph William, M.A., 3, Cripplegate-buildings, E.C., and Stewardstone, Chingford, Essex.
Milward, James, 54, Charles-street, Cardiff.
Mitchell, Thomas, F.R.I.B.A., Alexandra-park, Oldham.
Northall-Laurie, Reginald, 7, Stratton-street, W.
Oates, Eugene W., 6, Tenterden-street, Hanover-square, W.
Paget, Berkeley, 20, Lexham-gardens, Cromwell-road, S.W.
Peake, John, 65, Colebrooke-row, Islington, N.
Perry, Robert, Vernon-house, Spring-grove, Isleworth.
Prager, Alfred J., L.D.S., 351, City-road, E.C.
Reddie, Arthur William Lovell, 66, Chancery-lane, W.C.
Reed, Henry, 14, Union-street, Portsea, Hants.
Ricci, L., 15, Frithville-gardens, W.
Richmond, Henry, Haringey-park, Crouch-end, N.
Scott-Moncrieff, W. D., C.E., 1, Fairholme-road, Kensington, S.W.
Seymour, W. Hamilton, the Clyde Steam Printing Works, Howard-square, Glasgow.
Short, John, Sutherland-house, 101, Abbey-road, N.W.
Single, John Godfree, A.M.I.C.E., care of Messrs. Grindlay, Groom & Co., Bombay.
Slight, George Henry, 413, East-India-road, Poplar, E.
Stubbs, William, Phœnix Wharf, Commercial-road, Lambeth, S.E.
Tanner, Prof. Henry, M.R.A.C., F.C.S., 19, St. Oswald's-road, West Brompton, S.W.
Thomas, William, 27, Victoria-road, Kentish-town, N.W.
Thurkle, Edward, 7, Denmark-street, Soho, W.C.
Usher, Joseph, 25, Barnsbury-park, N., and 105, St. John-street-road, E.C.
Verney, Captain Edmund W., R.N., Rhianva, Bangor, and Travellers' Club, S.W.
Wetter, Jasper, 67, Strand, W.C.
Wiggin, Henry, M.P., Metchey-grange, Harborne, near Birmingham.
Wild, Joseph H., 53, Emma-place, Stonehouse, Plymouth.
Wood, William Martin, 25, Castletown-road, West Kensington, S.W.
Xifra, Narciso, 24, Mendizaba, Barcelona.

The Paper read was—

THE DISTRIBUTION OF TIME BY A SYSTEM OF PNEUMATIC CLOCKS.

By J. A. Berly, C.E., A.S.T.E.

Recent visitors to Paris—and the Exhibition of Electrical Appliances just closed has increased, during the past few months, the number of such visitors—must have noticed the numerous clocks standing on graceful light iron pillars in the squares, at the corners of streets, and in other conspicuous positions throughout the city. Many visitors must also have found that the clocks throughout their hotels were, what is unusual with hotel clocks, keeping accurate time. All these clocks, both public and private, are actuated by a single system of compressed air; and I thought it would be interesting to the members of this Society if they could be shown the precise method by which these important results are obtained. Paris and Vienna are the only two capitals in which such a system is now at work, but I cannot doubt that, as soon as the inhabitants of other cities know how great an advantage it is to have their time accurately marked for them, alike in public places and in their houses, it will not be long before a similar system is adopted in the towns and cities of this and other countries. I believe a general impression exists that the clocks in Paris are worked by electricity, as indeed is the case with a number of clocks in Brussels and elsewhere. You are, of course, aware that in London there are a certain number of clocks regulated by electricity from a common centre—indeed, the clock in this very room is so regulated. It is no doubt possible to accomplish this end by means of electricity, and even with more accuracy than is the case with the pneumatic system; but this can only be obtained at a vastly increased cost, and I hope to be able to show you that one can obtain, by means of compressed air, quite sufficient accuracy for all the practical purposes of daily life. In electrical clocks, a clock itself, and it must be a tolerably good and expensive clock, is required. This is regulated, it may be every hour, by an electric current; the clock goes during the remainder of the hour without regulation, and, of course, it may be relied on during that hour to keep time as accurately as its mechanism will allow. The clock requires to be wound up; if it is not wound up and repaired, it gets out of order or stops, like any other clock. If anything goes wrong with the battery, the regulator no longer works. In fine, an electrically-regulated clock is rather more a delicate scientific instrument than a practical piece of apparatus for the rough and ready purposes of ordinary life.

Now, with our pneumatic clocks, the case is different. They are not, indeed, regulated to fractions of a second, but, after all, nobody ever wants to keep appointments by fractions of a second, and trains have not arrived at that pitch of punctuality that it is necessary to calculate by seconds whether one can catch a train or not. In the pneumatic system, one single good clock is required. At each station where time is to be shown, a very simple apparatus (the construction of which I shall shortly have the pleasure of showing to you) is all that is required. This requires no attention from year's end to year's end. Like any mechanical apparatus, something may go wrong, and the clock may stop, but so long as it is going at all, it is going right. In any event, it requires no attention, in the case of a private house, from the person residing in the house. When once the system of pipes is laid down, the addition of almost any number of clocks makes no practical difference in the working. It is found in Paris that the Company can undertake to supply and maintain clocks in a private house for ¼d. to ½d. per day per clock.

Before the present successful experiment in Paris, several attempts were made to transmit time by means of compressed air; the earliest of these, so far as I have been able to ascertain, was made in the year 1864.

In 1877, Messrs. Popp and Resch, two Austrian engineers, after having spent much time and money in practically studying the question of transmission of time by means of compressed air, and after a great many disappointments, resulting from the imperfection of the results which they obtained, set to work, confident in the ultimate success of their efforts. They were able, on the 23rd of February, 1877, to inaugurate, in Vienna, the first public service of distribution of time by means of compressed air. A certain number of clocks fixed in public buildings, and erected on lamp-posts in the public thoroughfares, were kept at work uninterruptedly for a whole year; the distance between the central works and the farthest being very nearly one mile, viz., 1,500 mètres. The hands of the said clocks were at that time only propelled every two minutes, and two minutes at a time. During the first year, Messrs. Popp and Resch were able to carry out certain very important experiments (the details of which would perhaps be tedious) on a length of 2½ miles of pipes; and having ascertained that the compressed air issuing at one end did not take more than 3¼ seconds to travel to the other end, with of course a certain loss of pressure, they took steps to transform all the clockwork, and to alter the arrangements of the central works, so as to propel the hands of the pneumatic clocks every minute, instead of every two minutes.

Messrs. Popp and Resch exhibited their system at the Paris Exhibition in 1878; it attracted much attention, and the jury awarded them a silver medal. At the end of the year 1880, a proposal was made to the municipal authorities of Vienna to supply the time pneumatically to the town, authorisation being asked at the same time for laying pipes where they might be required; the said authorities, although consenting at the time to let all the necessary pipes be laid down where required, declined to grant a monopoly of fifty years, which was sought for. This caused the Viennese Pneumatic Clock Company to cease the experimental distribution of time in that town.

In November, 1878, Messrs. Popp and Resch, obtained from the Paris municipal authorities the authorisation to lay pipes in the sewers of the first and second arrondissements. One month later, a further authorisation was granted them for distributing the pneumatic time into private dwellings.

On the 1st of August, 1879, a Company was formed, the name of which was the Compagnie Generale des Horloges Pneumatiques, Système Popp-Resch, and the work of the erection of the central works, and of laying the systems of piping, began at once, and was pushed with the utmost vigour. On the 15th March, 1880, the inauguration of the public service took place, six miles of pipes having been laid and four clocks (some with multiple dials) fixed on lamp-posts on the grand boulevards, which received the pneumatic time from the central works. The only trouble and annoyance experienced had nothing to do with the working of the system, which gave all the satisfaction that could be desired, but was due to mischief done by people who, from interested or other motives, interfered with the pipes. A proper look-out was kept, the clocks continued to work satisfactorily, and they are now an established institution, the public regulating their watches from the pneumatic clocks.

Nearly twenty miles of main pipes are now laid in the sewers, and 750 houses, in which there are over 4,000 pneumatic clocks, are actually connected with and receive time from the main works; fourteen public clocks, with thirty-three dials, being fixed in the public thoroughfares of the above-mentioned arrondissements. At the main works, which are situated in the centre of the said districts, air is compressed by means of steam-engines actuating some air-compressing machines, and stored into air receivers or reservoirs, at a pressure varying from 15 to 45 lbs. to the square inch. The air so compressed and stored is led into distributing receivers, after passing through a pressure regulator. A periodic transfer or discharge of compressed air from the high-pressure receivers into the distributing one takes place, replacing the quantity of air which is at every minute discharged from the distributing receiver into the piping for actuating the clocks. The pressure of the compressed air in the distributing receiver is, therefore, constant.

The central or main clock, controlling all the system of pneumatic clocks, is a pendulum clock of great precision and perfect mechanism, and to it is connected a particular contrivance, specially adapted for the working of an equilibrium or balanced slide, which is successively opened and shut by the action of the main clock. The said main clock is, itself, self-winding, that is to say, the counterweights which are actuating the main clock are constantly brought back to their former position by the action of the compressed air, and this at each pulsation of the compressed air.

The hands of the main clock are travelling in exactly the same manner as those of any ordinary clock, and the valve, the motion of which is dependent upon the mechanism propelling the said hands, is actuated twice in every minute; the first operation, opening the valve, takes place at the sixtieth second of every minute; and the second operation, shutting the valve, twenty seconds after; so that the valve remains open, and compressed air is admitted into the systems of piping for a duration of twenty seconds at every time. This space of time is the result of experience, and may vary according to the distances to which the compressed air has to travel.

The valve chest is in direct communication with the distributing air-receivers in exactly the same manner as the valve chest of a steam-engine is in communication with the steam boiler; it thus contains compressed air always at a constant pressure. Therefore, when the valve is opened by the action of the main clock, there is a flow of compressed air in the systems of piping, and all the clocks branched upon the said piping are actuated at the same time.

A duplicate main clock, with a valve attached, is kept going, and giving exactly the same time as the other; the valve being disconnected, so that, in case of anything happening to the main clock, the connection of the duplicate main clock with its valve is instantly and automatically made, and there is no interruption in the distribution of time. The pressure of the compressed air in the high pressure and distributing receivers, the motion of the main clock and its duplicates, as well as the self-winding mechanism and motion of the slide-valve, &c., are all automatically controlled, so as to require a minimum amount of supervision, and anything abnormal occurring is instantly and automatically signalled.

The piping actually laid down in Paris in the "arrondissements," or districts, is 20 miles long. It is at the centre or point of departure divided into ten distinct parts, radiating from the centre and leading to various quarters; these 20 miles of main are composed of iron pipes, the inside diameter not exceeding one inch (in French measure, 27 millimètres). All these main pipes are fixed in the sewers, and wherever the time has to be delivered, transmitted, or given to a customer, an ordinary gas cock is inserted on the main pipe opposite the customer's house, and a branch pipe led from it into the building. This branch pipe is of a quarter of an inch diameter.

At each floor or landing, as many small

cocks are inserted on the ascending branch pipe as there are tenants; and, on any tenant subcribing to the pneumatic systems, a smaller pipe, $\frac{1}{8}$ of an inch diameter, is sub-branched on the ascending branch, and led into his apartments, where it is connected to the various clocks which are to be actuated.

No difficulty has ever been experienced with landlords as regards permission for carrying pipes into houses. Over 750 houses in Paris, in the two districts or "arrondissements" above mentioned alone, are thus connected with the main system, 177 miles of branch and sub-branch pipes being thus laid beside the 20 miles of main pipes already mentioned.

Leakages inside the houses or dwellings, as well as in the main pipe, have no influence with the general working of the system; even supposing one of the main pipes to be completely severed, the working would only be interrupted in that portion of the system which is situated farther than the fault, and any fault in one of the mains would not in any way affect the other mains. As to leakages occurring in private or dwelling-houses, they are of no influence at all, excepting on the very clocks which they are supplying in the apartments where the leakages exist, and on the central works being informed of the occurrence, the fault or leakage is made good immediately. It may be said that the Compagnie Generale des Horloges Pneumatiques of Paris has now, in the working of their system, reached a point of absolute security; and on the 19th July of this year a contract was entered into between the town of Paris and the said company, granting the latter the authorisation, for a period of fifty years, of laying and fixing their pipes underground for the purpose of actuating clocks by means of compressed air carried through the said pipes.

Having now generally described the system of pneumatic clocks, I will more fully illustrate it by referring to diagrams, skeletons, model clocks, and the apparatus, and clocks themselves.

Fig. 1 is a diagram giving a general idea of a central station as working in Paris. Power is supplied from a pair of engines, A A, driving a countershaft, from which belts are led off to drive the compressors, B B, of which a group of four are shown. They are vertical double-action compressors, made by Messrs. Sautter, Lemonnier and Co., of Paris, of their usual type, and the air passes from them by the four pipes, 1, 1, 1, 1, to the branch pipes connected with the high-pressure reservoirs, C C. As will be seen, the supply from each compressor can be discharged into either of the receivers at pleasure. From these receivers the air is conducted, somewhat circuitously, to the low-pressure receiver, D, although direct communication can be established, if desired, between the receivers, C C, and the pipes leading to the valve-chests of the controlling clocks. The object of the vessel, D, is to maintain in it the compressed air at a lower, but always equal, pressure (about seven-tenths of an atmosphere), and the periodical loss due to the discharges each minute are made good by the air from the reservoir, C, the supply being controlled by the governors, E E. One of these governors is shown on a larger scale by the section Fig. 3. From this it will be seen to consist of a lower closed chamber, A, and an upper open one, C. These two communicate by a central passage, which is extended by a tube almost at the bottom of A. In the chamber C is a float, E, connected with a rod attached to a lever, working the tap 3, Fig. 1, and also shown on a larger scale on Fig. 2. The dotted circle, *a*, indicates the position of an inlet for compressed air. The chamber A is partially filled with mercury, and the pressure of air admitted to A forces the mercury up into the chamber C, raising the float, and thereby actuating the controlling tap. As will be seen from Fig. 1, there are two of these governors, and they are worked by air from the reservoir D, which passes through the pipe, and branches off to each of the governors. It will now be understood that the air leaving the reservoirs, C C, by the pipe 2, flows along until it is arrested by the intermittent acting taps 3, 3, connected with the governors, E E, then each time these taps are opened the air passes into the pipes 5, 5, and thence into the constant low pressure reservoir. Fig. 2 shows this part of the apparatus to a larger scale and in greater detail than the diagram, Fig. 1. In this figure the low-pressure reservoir is shown at R, and A A is the small pipe with its two branches leading to the governors A. On these governors are gauges, *p p*, indicating the level of the mercury. Air from the high-pressure reservoir enters the valve chest, which is shown in section in Fig. 6, and with one half of the cover removed in Fig. 5. There are three openings in the chest: at *m*, by which the air enters from the reservoir through pipe *h*; at *n*, where it passes to the mains by pipe K; and *o*, which is the exhaust shown at *p* in Fig. 5. The valve, *r*, is provided with a friction roller, which runs on a bar placed across the chest, and the outer end of the valve spindle is articulated passes through the pipe, D, past the tap, H, to the branches controlled by the taps, C C, these taps being moved by the rods, *m*, attached to the regular floats. Intermittent discharges of air are thus permitted to pass through the rectangular system of pipes shown enclosing the governors, past the tap, *e*, and through the pipe, *d*, into the reservoir, R. The pipe, *s*, is the one which conveys the air from R to the valve chest, and is shown at 7 on the general plan, Fig. 1. It will be noticed from this same diagram, that the series of pipes leading to the clocks is in duplicate, one set having been employed, and the other kept in reserve in case of accident. The two clocks are shown at F F; the air-supply pipe is marked 7, the exhaust from the valve chest, 9, and the air to the mains is delivered to the pipe, 8. One of the clocks, F, is shown in detail by Figs. 5 and 6. It is of course necessary that this should be as accurate a time recorder as possible, and its two special characteristics are, that it is self-winding, so that it never requires to be touched, except for repairs or regulating, and that it actuates periodically the slide-valve, which is the vital organ of the whole system. In the drawing, *b* and *c* are respectively the driving weights of the clock, and the slide-valve mechanism; *d* and *e* are the levers through which those weights are lifted periodically; and *f g* are the cylinders, in which are the pistons connected with the levers. Compressed air is admitted every minute beneath these pistons, and the weights are thus raised; the cylinders are kept supplied through the pipe *v*. On the right hand side of the figure *h*, is the pipe (marked 7 in Fig. 1) leading from the low-pressure reservoir, and K is the pipe leading into the chamber connected with the systems of distributing mains. These two pipes enter at one end of the lever, which at the upper end is connected to the eccentrie rod, *s*, the eccentric being worked by the clock mechanism as shown. Above the valve chest are placed three three-way taps, R R R, two of which communicate with the inlet and outlet passages of he chest respectively, while the middle one ens a clear passage between the pipes *h* and By this arrangement, the system can, in se of emergency, be kept going, since by opening and closing by hand every minute the middle tap, the same result is produced as that given by the slide-valve. The valve-chest is always in communication by the opening, *m*, with the low-pressure reservoir, and during a period of above twenty seconds in each minute the port *n* is uncovered, admitting air to the system of pipes; at the expiration of this period the port *n*, and exhaust port *o*, are in communication during the remaining forty seconds of the minute, a time sufficiently long to re-establish an equilibrium in the main. As stated above, the clock mechanism which we have described is duplicated at the central station, together with the system of supply, distributing, and exhaust pipes, as indicated in the general diagram, Fig. 1. Figs. 7 and 8 show the arrangement of the indicator provided to give notice if the automatic winding apparatus does not act. It will be noticed in Fig. 5, that between the main weights, *b c*, there are two smaller weights, *x*, the chains passing round the pulleys attached to them, as well as over those of the main weights. The devices shown in Fig. 7 and 8 are placed on the clock frame. The arrangement of both is identical. It consists of a bar, A, the axis of which coincides with that of the weight, *x*, bolted to the brackets, B. Through the centre of the frame passes a vertical rod, H, held up by the spiral spring, N. To the top of H, is articulated the horizontal lever, G, pivotted at O, and connected with the curved spring, L, at the lower end of which is a platinum contact piece, M, so that when the spring presses on the plate carrying the terminal shown in the figures, an alarm is given. Through the lower end of the rod, H, passes a long curved bar, *c*, at the extremities of which are two spiral springs, E, that terminate in hooks, engaging in the axis of the pulleys, carrying the weight, F. This weight is that marked *x* on Fig. 5, where the attachment to the pulley is indicated. When the main weights are wound up as they should be, each minute, the counterweights, *x*, descend, and there is no contact between the platinum, M, and the terminal plate; but if the main weights are not raised, and continue to fall below their proper level, the counterweights are raised, and through the device just described, contact is effected, and the alarm bell is rung. We may now pass on to the arrangement for distributing the air impulses through the system of mains. This is shown in the diagram, Fig. 1, and also in detail by Fig. 9; from these figures it will be seen that two mains pass into one side of a box, on the other side of which are a number of branches corresponding to the *réseau* of distribution. The two mains are marked 8·8 on Fig. 1, and pass from the valve chests of the two controlling clocks. Of course only one of these mains is used at a time, depending on which of the clocks operates the system. The mains (see Fig. 9) are furnished with two taps, *a a*, on the spindles of which are spur-wheels gearing into a pinion, *m*, which is worked by a lever, *n*. By turning this lever, one tap is opened and the other closed, so that communication can be established instantly with either of the two clocks. The air passes into the cast-iron reservoir, *c*, to which are bolted by flanges five branches, with taps, *d d*. On each of these is a double branch, *e e*, which communicates with the air mains, *b b*, through the taps, *f f*. By this arrangement it will be seen that the whole system is under complete control, as any desired number of the branches, *d*, or mains, *b*, can be shut off at will. It will be noticed that, connected to the mains, *b*, are two taps, *g*, and small pipes connected to them. In Fig. 9 only these are shown, but one small pipe is attached to each of the mains. Each of these goes off to a gauge in the central office, so that the pressure in each main can be always observed. Another pipe is led from one of the mains to the mercurial control apparatus, for indicating the working of the slide valves, and which is shown at H, Fig. 1, and in section, Fig. 4. This apparatus consists of a glass mercury column, *b*, entering a mercury chamber, *a*. The top of the column is closed, except for the openings, *n m*, which are controlled by the valves, *g*. There are two electrical contacts, *f* and *f*, one in the upper part of the column and the other in the top of the mercury chamber, *a*. A tap, not shown in the figure, and entering the cover, *e*, of the chamber, *a*, leads the compressed air from the main, *b*, Fig. 9, into the chamber, *a*, so that as each impulse takes place in normal working, the mercury column ascends in the upper chamber, and afterwards descends in the lower one, no contact taking place; but should the slide-valve fail to act, the mercury column, by continuing to rise into the upper chamber, or to descend into the lower one (according as the valve fails to open or to close) establishes an electric contact with one or other of the two contact points.

The mechanism employed in recording the time, either for large public clocks or small domestic ones, is of the simplest character. Two kinds are shown in Figs. 10 and 11, the former being adopted for striking the hours and half hours. Taking the latter first, it will be seen that motive power is contained in the box, B, and consists of small concertina-like bellows, which expand under each impulse of air brought by the pipe shown beneath the box, B. The bellows are shown separately in Fig. 12, and it will be seen that they are made of a series of soft rubber discs, connected in pairs at the edges by brass rings doubled over, and at the middle in alternate pairs by another set of rings, with central holes communicating with each of the compartments. These bellows, placed within the box A, are secured to the bottom of it by the adjusting screw H, and on the top of the bellows, which is formed of a thin brass disc, rests a piston, B, formed with a vertical rod, which, passing through the top of the box, is pivotted to the lever, *c*. This lever, which is hinged to the bracket on the same axis as the clock, where D is of the form shown in Fig. 12, and between the piston and the fulcrum, carries a pawl, E, hung on the centre formed in the enlarged part of the lever, *c*, and carrying a counterweight which, holds it against the face of the wheel D. On the other side is a balanced detent, F, and G is a plate provided with stops, as shown, to regulate the range of the lever, *c*. As each air pulsation expands the bellows, the lever with its pawl E is raised, turning the wheel, D, which has 60 teeth, through the space of one tooth, while with each contraction the lever, *c*, descends (this being insured by its being weighted at the outer end). This operation is repeated minute by minute, and a simple wheel train gives motion to the hour hand. For striking clocks, the arrangements are somewhat modified, as in figure 10, the lever *c* being in this case provided with a fork, D, between which is a pin connected to the striking spring, which is wound at each impulse through the motion of the lever.

Figure 13 is a sketch showing one mode of arrangement, a mode largely adopted in Paris, where the sewers afford facilities for laying the pipes. In the figure A is a main, having a diameter varying from ·6 in. to 1 in., according to the importance of the service. The tap B is fixed on the main, to establish connexion with the house opposite which it is placed; C is a lead service pipe, from ·24 in. to ·39 in. in diameter, passing into the basement of the house; D is a three-way cock, placed on the pipe for convenience of making future connections; E E are taps put in the pipe, C, on the different floors of the building; F F are branches, of from ·12 in. to ·24 in. in diameter, proceeding from these taps along the ceilings into the rooms; G is a rubber tube, ·12 in. in diameter, attached to the lead pipe, and brought along the cornices and down the wall to where the clock is placed. Figure 14 is a section showing a main laid in the ground with the connexion to the house. In this case, the branch is furnished with a tap that can be opened and closed by a key from the street level. Figure 13 shows the relative sizes of the pipes generally employed, the two largest being used for mains, and the two intermediate sizes for service pipes, and the smallest, the rubber tubes leading the air into the apartments. The distribution of time to private individuals is effected by the Company under the following conditions:—

The subscription must be for at least one year, and is renewed for not less than one year at a time.

The Company supplies, free of cost, to the subscriber, clocks of various patterns, which can be selected at their show-rooms. They also undertake, at their own cost, all the work of fixing and laying pipes, supplying the necessary materials required for such, of connecting and fixing the clocks, substituting, when desired, the clockwork of their system for the clockwork of existing clocks, and keeping the clock in good working order.

Their charges for supplying the time are as follows:—5 centimes a day (or 14s. 7½d. per year) for the first clock; 4 centimes a day (or 11s. 6d. per year) for the second clock; 3 centimes a day (or 8s. 9½d. per year) for the third and others.

The piping, connexions, clocks, &c., remain the property of the company, and statements to that effect are signed by both the proprietors of the house, and the tenant subscriber to the clocks. A due authorisation must, of course, be previously obtained from the landlord. There is no example yet of any landlord having refused to give it.

The main features of the contract entered between the town of Paris and the Company are as follows:—

1. The town of Paris grant to the Company the authorisation for fixing and keeping under the streets, the pipes for conveying compressed air for the purpose of the pneumatic distribution of time, and this for a period of fifty years.

2. At the expiration of the contract taking place naturally, at the end of fifty years, or before that delay, should the contract be determined, for any cause whatever, all the pipes, taps, connections, &c., or otherwise materials, placed underground, or in establishments of the public service, become the property of the town of Paris, the town of Paris having the option to purchase or not the plant, &c., existing at the works, and in the central stations.

3. All the expenses of carrying out the air compressing works, central stations, and systems of piping from each station, for the scheme is to be borne by the Company.

4. All pipes to be fixed in the sewers, wherever these are found to exist, and those fixed in trenches to be removed to the sewers as soon as those are completed.

5. In large thoroughfares, where there exist two sewers, two main pipes should be fixed—one for each side of the street.

6. The rental of the underground pipes to be paid quarterly by the Company to the town of Paris, is fixed as follows:—For each kilometre of main, 20 francs per year (or £1 5s. 9d. per mile per year); for each branching for private clocks, while their number does not exceed 10,000, five-pence.

When the number exceeds 10,000, 5½d. for each per year; 11,000, 6d.; 12,000, 6½d.; 13,000, 7d.; 14,000, 7½d.; 15,000, 8d.; 16,000, 8½d.; 17,000, 9d.; 18,000, 9½d.; 19,000, 10d.

7. The Company undertakes to instal, keep in working order, and renew, if necessary, any number of public clocks which the town of Paris may, at certain agreed periodical times, instruct the Company to fit up for them, and under the heading of public service are comprised all the clocks of cab stations, kiosks, street clocks mounted on lamp-posts, the clocks of the town hall (Hôtel de Ville), and all the arrondissemente town halls (or mairies), the police-courts and police-stations, the patrolling stations, municipal barracks and theatres, schools, markets, slaughterhouses, parks, and squares, churches, &c.; the town paying for such clocks at the following rates:—Clocks from 3 feet 4 inches to 17 feet diameter, per year, each, £2 5s.; medium sizes, from 2 to 3 feet diameter, per year each, 12s.; small sizes, under 12 inches diameter, per year each, 1s. 8½d. After a lapse of five years, those prices to be reduced by 20 per cent.; five years after, 30 per cent.; five years after, 50 per cent.; five years after, 75 per cent.; and after a lapse of twenty-five years, the same to be gratuitous.

8. The Company shall deal as they think fit with their private customers, this constituting the commercial part of their concern. There are, besides, numerous clauses regulating, as it is usual in contracts between municipalities and contractors, the conditions in which the works shall be executed, maintained, controlled, &c., the fines to be paid in cases of non-compliance or irregular supply, &c.

The Compagnie des Horloges Pneumatiques has undertaken to complete the public service of distribution of time in Paris, at the following periods:—In the 1st and 2nd arrondissements, within six months; in the 3rd and 4th, in the course of the year 1882; in the 8th and 9th, 1883; in the 6th and 7th, 1884; in the 5th, 10th, 13th, 19th, 1885; in the 11th, 12th, 14th, 15th, 17th, 18th, 20th, 1886. It will be seen that within a delay of five years the whole of the public service of Paris will be completed, the system of piping extending to the whole town, and all the clocks of the town being worked by the Company's pneumatic system.

In order to carry out the contract with the town of Paris, it is now proposed to divide Paris into nine sections, each working independently with its normal clock. Each of these nine stations will supply from 35 to 45 miles of main street-piping, so that the total of main pipes, sufficient for the distribution of time in 50,000 houses, would be about 360 miles. One central air-compressing station is being erected in the Belleville quarter of Paris, and will supply the compressed air to the distributing stations to which it will be connected. It is estimated that the clocks coming under the heading of "public clocks" will number about 8,000. It is estimated that a piece of ground, of an area of about one acre, would be sufficient for the erection of the central works, in which the engine-houses for the compression of air, the motive power, air pumps, fitting shop, &c., the offices and residences for the chief engineer and foreman, would find room. The cost of the ground is estimated at £7,200. The cost of the buildings, containing three 50-horse power engines, five air-compressors, two pumps, the workshops and the residence for officials, is estimated at £6,800. The cost of plant, consisting of two steam boilers of 100-horse power each, three 50-horse power engines, two air compressors, of laying down lighting by electricity, water, shafting, &c., and furnishing the offices, &c., is estimated at £8,000. The machines, tools, for the workshop, at £400. The thirty-two high pressure air receivers (107 feet long × 5 feet diameter), £9,400.

Each distributing station having two normal clocks and their appurtenances, five distributing or low-pressure air receivers would cost, together with the furniture, fixtures, &c., £1,000; the nine would therefore cost £9,000. The laying of 600,000 metres of main pipe, the branching to 50,000 houses, and the installation of 200,000 clocks, will cost £400,000. The horses, traps, office furniture, £400. The total expense will therefore be £441,200.

The working expenses are estimated as follows:—A. Central works, wages, £600; B. Water and fuel, £1,600; C. Distributing stations, wages, and current, £6,400; D. Carrying department, £960; E. Central administration, salaries, wages, and current expenses, £3,200; insurances, rates, taxes, management, &c., £3,200; or a total, in round figures, of £16,000. It is estimated that the whole of the works will be completed in two years, each section being, meanwhile, brought to completion from time to time.

The Company, in carrying out the experiment on a comparatively large scale, of pneumatically distributing the correct time to public and private clocks for a period of 15 months, have demonstrated the absolute practicability of the scheme, the demonstration having resulted in the contract for 50 years already referred to, and they have also ascertained with what favour the extension of the system is likely to be received by the public.

The result has been highly satisfactory in every respect; and it is anticipated that the number of clocks which (judging from the facts which have characterised the experimental period) will, putting it at a minimum, be subscribed for when the whole of the expenditure above mentioned has been effected, and the system is extended to the whole town, bringing a gross income of £128,000.

A pneumatic Clock Company is very similar in its establishment, working, and effects and results to a Water Company. A great many instances have been found in which the amounts paid in the same house for water and pneumatic clocks were similar, and to cite one instance, the well-known Meurice's hotel, in which there are 148 pneumatic clocks, pays to the Clock Company a sum of £56, which is exactly the amount which they pay to the Water Company for the supply of water to the whole of their establishment. Another striking coincidence is to be found in the comparison of the Lyons Water Company and the Pneumatic Clock Company. The cost of establishment of the Lyons Water Company, was £508,000; that of the Pneumatic Company, £441,200. The working expenses of the Water Company are £16,920. The working expenses of the Clock Company have been estimated at £16,000. The gross income of the said Water Company is £64,960. The estimated gross income of the said Clock Company is £128,000.

The pneumatic system of distributing the correct time to distant clocks can be successfully applied to all towns of a certain importance.

The application of the system in London would not differ very much from that in Paris. London is, it is true, a very much larger city than Paris, but it has, on the other hand, a corresponding number of houses and inhabitants; more distributing stations would be required, owing to the larger area to be covered, but not to the number of clocks to be maintained, as an almost unlimited number of clocks can be maintained from the main pipes of the distributing station. There is one circumstance rather in favour of the system in London which does not exist in Paris, viz., that the City being almost entirely devoted to business, those who use it in the day time mostly reside far away from it, and thus an enormous number of clocks are, so to speak, duplicated, the commercial people requiring clocks both at home and in their places of business in the City. Another favourable circumstance is to be found in the fact that the majority of the shops in London are provided with clocks, while in Paris this is the exception.

Although it could not be maintained that the possession of the correct time is an absolute necessity to the community, such as water is, it can safely be asserted that from a convenience it is rapidly becoming a necessity. The old English proverb, "Time is money" is becoming more and more an axiom; with a tendency to work less and less, and to condense work more and more; with the increasing facilities afforded in travelling; with the alterations introduced from time to time into the laws regulating labour, &c., the want of the correct time may be said to be felt more severely every day. It cannot be maintained that gas is a necessity, excepting that it has become so owing to the force of habit, the convenience which it affords, the comfort which it provides, and its economy compared to other illuminants. Gas took the place of candles and oil, and where gas is not an established institution, or is likely to fail, the services of candles or oil, are, or can be, put into requisition. But the trouble of procuring the candle or oil, the trimming the lamps, the complication of attending to so many objects, coupled with the cost of maintaining them, have contributed to make gas popular, and very generally adopted.

The comparison between ordinary and pneumatic clocks will, in a similar way, stand good in favour of the latter. Ordinary clocks are expensive to purchase; they require winding up periodically (the majority of them weekly); they are either fast or slow; rarely correct; they are often out of order; frequently require repairs, and are affected by the weather, especially in severe frosts.

Should the care of winding them up and keeping them in good order be entrusted to a watchmaker, the cost of it, leaving out the inconvenience and annoyance attached thereto, would even prove dearer than the charges for receiving pneumatically the correct time; the Company taking all the risks, and supplying everything, down to the clocks themselves, free of cost, and no annoyance or discomfort being attached to the maintenance of the said supply in the manner described; it can therefore safely be assumed that what has occurred in the case of gas, will, in a like manner, occur with pneumatic clocks, and the general adoption of these is only a question of time, not pneumatically speaking. In a similar manner, the electric light and the telephones will soon become necessities of our existence, the one taking the place of gas, and the other (who knows) perhaps, the place of telegraphy.

And when I say that the adoption of the pneumatic clocks is only a question of time, I intend to convey that it will, most likely, soon become general, as now-a-days progress is notable, and a thing has no sooner proved itself to be of industrial or commercial value value, than it is widely adopted, and soon becomes an established institution.

APPENDIX.

It may be interesting to enumerate some of the many purposes for which compressed air has been employed. Air, compressed at pressures varying from a little over, up to over a hundred times above the atmospheric or natural pressure, has, and is used in reference to, amongst many others, the following processes or manufactures:—

The blowing of glass and bottles, &c.

The blow-pipe, so much used in chemistry and industrial processes.

The "blow cane," for killing birds, as used by the natives of Guiana for killing paradise birds without destroying their valuable feathers.

The common bellows used for fire-sides; in the slaughtering-houses, &c., and also in blacksmith shops, &c.

The blowing of organs.

Blasting in foundries, forges, cupolas, &c.

Diving Bells.—A description of this apparatus, in its primitive form, is given in Aristotle's "Problems," as far back as in the 4th century B.C.

Diving Dresses.—Those have almost superseded the diving-bells, which only allowed the workers, or divers, to extend their operations over a very limited area at one time, when, with the diving dress, the worker is capable of moving to and fro, having only to carry with him the pipe which convey to his mouth the air compressed at the surface by means of pumps of special description.

Sinking Bridge Piles.—With the progress of metallurgy, the construction of metallic bridges come gradually into use, as also the use of cast-iron tubular pillars. Air compressed at a pressure sufficient to keep the water out of the pile during the process of sinking, in order to enable the workmen to work at the bottom of the water, is forced into the tubular cast-iron pipe, and maintained at the required pressure, the top part of the cylinder being shut, and a special contrivance or air chamber provided for the letting in and out of the men, and materials excavated.

Floating Sunken Vessels.—Various devices are in existence for floating sunken vessels, the means generally employed being the pumping out of the water contained in the hold, combined with the use of air bags surrounding the vessel, to which they are attached in suitable positions by divers.

Locomotion.—We have examples of railway locomotion by means of air pressure in the atmospheric railways of St. Germain, in France, which was at work in the year 1847, and of Dalkey, in Ireland; also in the compressed air locomotive of Mr. Ribourt, a French engineer, as constructed at the Creusot's works, and used in St. Gothard's tunnel works, and of that of Lieut.-Colonel Beaumont, as tried at Woolwich some time ago.

Brakes.—Powerful railway brakes, now well familiar to us, are also worked by air pressure, such as the well-known Westinghouse compressed air and Smith vacuum brake.

Tramways are also worked by compressed air, and the most successful of the existing system is, judging by the number of applications which it has received, the Mekarski system, in which the air, compressed at a very high pressure (and which is carried in cylindrical receivers attached underneath the tram-car), instead of being used alone, is caused, before producing its expanding effects, to pass through boiling water, a load of which is also taken with the tram-car on its starting journey.

Rock-drilling.— The drilling of holes for blasting rock by means of gunpowder or dynamite, in mines, quarries, and tunnelling, is also effected by means of air compressed by machines actuated by steam-engines, water-wheels, or turbines, at the surface of the works or entrance to the tunnels, stored into proper receivers, and conveyed to the perforators or rock-drilling machines at almost any distance, in any direction, and at any altitude, by means of pipes connecting the air-receivers to the said perforators. The tunnels of the Mount Cenis, and the St. Gothard, one over eight and the other over nine miles in length (14,920 metres), have been evacuated throughout by means of such machines so worked by compressed air.

Coal-cutting.—For working coal-cutting machines underground in the same way as rock-drilling machines are worked.

Transmission of Power.—For transmitting power in any direction, at any distance or altitude; any ordinary steam-engine, steam-winch, steam-crane, &c., being capable of being actuated by compressed air in exactly the same manner as the said engines, machines, or apparatuses can be actuated by steam.

Ventilation of mines and public buildings.

Pneumatic Post.—Messages are now carried from one place to another, through underground, in some of the most important European capitals—London, Paris, Berlin, Vienna—vacuum and compressed air being used for the purpose.

The use of compressed air is also brought nearer home to us in our daily dealings in the shape of pneumatic bells, apparatuses for opening doors (as used by the Paris *concierges*), spray producers, fountains, air guns, toys, &c.

Compressed air is also used in sugar manufactories, breweries, iron and steel works (the blowing engines in these last being a very important feature in the processes of metallurgy); also for artificial ice making and cold producing, as in the Giffard process, in which the cold resulting from the distension of compressed air into the atmosphere is utilised; in submarine vessels, propelling of torpedoes, pneumatic dredgers, such as the Duckham's, the Bazin's, the C. Ball's; water-lever indicators, and, finally, in a variety of works, processes, and purposes which it would take too much time to describe.

I would only conclude by saying that, should an exhibition of the various industries connected with the use of compressed air be held in any convenient spot, it is my opinion that it would prove of an immense interest, and attract almost as much attention as the electrical exhibition of Paris, so numerous and varied being the valuable ends to which it is applied.

DISCUSSION.

The Chairman, in proposing a vote of thanks to Mr. Berly for his valuable paper, remarked that the invention described appeared to be of great utility, and he hoped it might be adopted in London. There seemed every probability of its being a commercial success in Paris; but there were certain advantages there which London did not possess; in the first place, the sewers were so constructed, that the pipes could be laid in them without breaking up the streets; and besides that, in Paris there was a municipal form of government, which enabled inventors to bring forward their inventions, and get them into operation, without all the difficulties which were experienced in England. He hoped, however, that before long there might be a municipal government in London. This invention was one of very great interest, the simplicity of construction of the clocks being very remarkable; it appeared that the principle could be applied to clocks of all sizes, and could be carried to great distances.

Mr. John Jones said he did not, as a watchmaker, know much about compressed air, but the system certainly seemed successful. At the same time, if it were generally adopted in London, he should fear that a period would come when London would be left without any time at all, that is if the central apparatus ceased to do its work well. There was no doubt that the public distribution of time was a matter of great importance, as was proved by the prevalence of parish and other public clocks; and the practicability of keeping an escapement at work by transmitted pulsations was equally incontrovertible. This was not at all new, as Bain's electric clocks did the same thing in former years; but then the electric current had its own vagaries, and was an unreliable friend, though it was thought at one time to produce the very perfection of work. Every now and then, however, with all modern improvements, the whole electric system of the kingdom was disturbed by some influence of which they knew little more than the results. Compressed air certainly seemed manageable, and could easily be made to give motion to an escapement, and through it to an hour and minute hand. Even if one had to contemplate the annihilation of one's trade, one could not help it; but centralisation was a thing which Englishmen always resisted. He thought they would prefer local independence—every householder having his own clock. There was no great necessity, after all, for such a system, and there was something in being independent of the care or indifference of some one of whom you did not know anything. All machines were liable to accident, and he contemplated the possibility of the steam-engine breaking down, the compressor exploding, the pipes bursting, or something else happening, which would leave the inhabitants in the unpleasant predicament of not knowing what the time was.

Mr. Lund said his brother, Mr. Henry Lund, who had invented a system of synchronizing clocks by electricity, was not present, but he might be allowed perhaps to say a word on the subject, showing how in one respect that system had an advantage over the one now advocated. Clocks which were not worked, but set by electricity, were practically always right, whereas these clocks were at certain intervals wrong. It had been said that electricity might and did fail, and so it did; but clocks set by electricity went by their own ordinary motive power, although of course they required winding; so that if the power which set the clock failed, the clock went on in the ordinary way, and the next current which came set it right, however great the error might be.

Mr. Hale said it seemed to him, that after allowing for depreciation, according to the figures given, these clocks might be kept going for about 5s. each per annum.

The Secretary asked what was the actual difference in time between a clock close to the central station and one at the furthest distance; because it was evident that the air must take an appreciable time in traversing a considerable circuit of pipe. The difference between clocks regulated by electricity and by this system was this. By the electric system you got absolute accuracy; any clock which was a clock at all would go for an hour, and if it were set right every hour within a fraction of a second, you might depend on its being absolutely right. On the other hand, with these very ingenious clocks, you got sufficiently accurate time for all practical purposes within a minute. If one looked up at a large clock, say on a church or a railway station, it was only in a certain position that you could tell the time at all accurately by it; if you were much on one side or under it you might mistake the time as really shown by the clock by several minutes, and it was obvious, therefore, that with clocks of this description minute accuracy was not important. He might say that Mr. Berly and those who had assisted him had spent a great deal of time, trouble, and doubtless money, in preparing the very elaborate system of clocks now at work, and he was, therefore, specially entitled to their thanks.

Mr. William Botly said he could confirm what the Chairman had said with regard to the facilities afforded by the Paris sewers for laying pipes in, as he had had the advantage some years ago of going through them. He remembered, thirty or forty years ago, when he was churchwarden in the country, the clock had been allowed to keep almost any time, and he ordered it to be kept at Greenwich time. The legal adviser of the Vestry said he had acted contrary to Act of Parliament, but the Vicar, who was by his side in the Vestry meeting, supported him, and in the end he received a vote of thanks for what he had done, instead of a vote of censure.

Mr. **Wolstencroft** asked if the moisture in the air acted at all injuriously when it was compressed.

The vote of thanks having been passed,

Mr. **Berly**, in reply, expressed his obligations to the Compagnie des Horloges, to Messrs. Popp and Resch, both of whom had come to give their assistance, to the Secretary of the Society, to the Compagnie Generale de l' Electricité, who had lit up the hall, and to Mr. Preece, who had lent assistants for fitting up the electric lights with which the hall was lighted. Mr. Jones referred to the danger of being left without time if the central service stopped; but the same danger applied to the gas supply, to a large steamship if her shaft broke, and to many other occasions. They did not profess that they could supply the time if the central system failed, but they took such precautions by duplicating the machinery as to reduce the danger to a minimum. The confidence of the Parisian muncipality had been shown in this system by their entering into a contract for fifty years, after having previously spent large sums in the attempt to distribute time by electricity. Centralisation might be an evil, but it did not apply to this system more than to electricity. Mr. Lund, in speaking of the advantages of clocks controlled by electricity, said they would be set right whatever might be the error; but he did not quite follow him there. The synchronising was done by two hands which caught the minute hand at the hour, or whatever interval might be fixed upon, and brought it either backwards or forwards, as might be required; and he failed to see how the minute hand could be caught by the synchronizing hand, if it were out of their reach. With regard to the cost of maintaining the clocks, he had not gone minutely into the financial side of the question, but if Mr. Hale's calculation was correct, that the cost would not be more than 5s. per annum, there was a good margin left, according to the prices charged. With regard to the time taken by the air to travel through the pipes, he was informed by Mr. Popp, that at a distance of five kilomètres, or a little over three miles, there was a delay of four or five seconds in the transmission. The largest discrepancy between any two clocks on this system would not amount to a minute. He was not aware that the moisture in the air would have any effect at all; the system of pipes was entirely closed, except at the central works. Where the compression took place, it was always full of air at the atmospheric pressure, the effect of the apparatus being only to increase the tension of the air contained in the pipes; the fresh supply of air introduced was very small, one hundredth of an atmosphere being sufficient to work the clocks, though they provided for more in order to allow for leakage, &c.

Mr. M. S. S. **Dipnall** inquired if differences in the barometric pressure would have any effect on the timekeeping of the clocks.

Mr. **Berly** replied that it had no effect whatever. He might add that it was a very simple matter to regulate clocks instead of working them by this system. The impulse could be communicated once an hour instead of once a minute, and so they might be synchronized in the same way as by electricity; but the inventors did not choose to stop at the mere synchronizing of clocks, which they did not think was a sufficiently complete operation, because it involved having a good clock to start with. They suppressed the clock altogether, and supplied the time altogether with a very considerable approximation to exactitude by the means he had endeavoured to describe.

Miscellaneous.

ITALIAN INDUSTRIAL EXHIBITION AT MILAN.

This exhibition of national industry closed on November 1st, and is said to have been highly successful. On the Sunday before the final closing, 21,000 persons paid for admission. The total number of persons paying for admission during the period the Exhibition remained open, was 1,546,567, the total receipts for ordinary admission and season tickets being £49,074 18s. 6d. A large number of workpeople visited the Exhibition, either through their societies, or in direct connection with their respective factories. Every effort was made by the corporations of the larger cities, and the large manufacturers, to enable their workpeople to see and profit by the advance shown in their respective industries. On one occasion there was as many as 860 women and girls from one establishment of silk manufacturers alone, while at another time 4,600 men, women, and girls employed in the cotton and linen industries, came from one district.

The following is a short description of some of the chief objects exhibited.

The whole process of the manufacture of silk was shown, from the propagation of the silkworm to the finished article in all colours, thread, ribbon, wide web, flowered silk, artistic designs, &c. In another part of the gallery were arangements for the making of cheese and butter, and also complete plant for preparing condensed milk, with the necessary machinery for making the cans; alongside of this a complete plant for chocolate making and sweets was in full work. As in Paris, a complete staff of lapidaries and jewellers were at work, enclosed in a partition of glass and wood; close by, the making of waterproof coats, garments, &c., in all stages, children's balls, balloons, tobacco pouches, &c., were shown. The materials were prepared in the factory in Milan, and the articles made up and vulcanised in the Exhibition. In the two galleries of machinery in motion and at rest, the mechanical engineers of Italy put forth their full strength, and nearly every firm in Italy is said to have sent something for exhibition.

As might be expected in a country where coal is scarce and dear, much ingenuity has been shown in the various kinds of "cut off" valves, adopted by the different makers, nearly all of which are attempted modifications of the "Corliss" valve. The boilers showed an improvement on the other engineering plant, but although the boilers were put together in Italy, much of the plate and fittings had evidently been made elsewhere. In this department many pumps were shown at work, but only two of them call for special comment, one a centrifugal, on the "Gwynne" system, designed for draining marshy land, the other on the patent "Universal" and "Special" direct acting system. Some excellent specimens of the coppersmith's art in all its branches were exhibited.

The extent of the engineering industry in Italy at present may be inferred from the number of towns sending specimens of their skill. In all, 35 towns have competed in the class of engines and machinery, but the number of towns does not give an idea of the number of factories, as several towns were represented by four or five different factories. The principal railway companies and makers of railway plant in Italy, united to make a good show, but although the engines, carriages, and trucks bear the names of the various factories, many of the most important parts are not of Italian manufacture.

One of the trains was adapted to serve for a travelling hospital in time of war; the train is on the "Pulman" system, 1st, 2nd, and 3rd, the 1st class being so arranged as to serve for surgeon's sitting-room, dispensary with apparatus and drugs complete, and a room suitable for performing operations and for the use of the attendants. The 2nd class is fitted up as a kitchen and dining-room, the kitchen having all necessary appliances for preparing and supplying food, &c., to at least 50 persons. The 3rd class, a long high carriage, is fitted as the hospital proper, the "stretchers" used for conveying the wounded also serving the purpose of beds; they are arranged in two tiers, each being supplied with hospital necessaries, while at the ends of the carriage two cupboards contain all necessary implements for dressing wounds, &c.

Adjoining the gallery, was one devoted to tramway apparatus, which was well represented. The steam "tram" is used in nearly all the towns in Lombardy, which are connected with Milan by this system.

The agricultural machinery consisted more or less of copies of the machines made by our prominent English firms.

There was a good display of finished iron and castings in the gallery of metals. One firm of founders in Bergamo sent the best specimens of general castings, and some beautiful ornamental work direct from the sand. There were three cases of cutlery, the work of which was well finished, and the range extensive; it was shown by a firm from Monza. The greater portion of this work is done in the houses and small workshops of the neighbouring villages, whole families being engaged in this trade, much in the same manner as the nail and chain trade of Staffordshire.

Adjoining the metals, in another large room, are the products of mining industry. Coal, iron, lead, and other ores were shown in considerable quantities, with details of the productions of the various companies.

In a square, in front of the principal restaurants, were models of bridges and viaducts, from various makers; as also models of the framework and scaffolding used in the erection, with details appended.

Some facts in regard to the progress of the cotton trade in Italy, may be gathered from the statistics given by the respective manufacturers. From this we learn there are twenty towns or districts in which factories have been established, the total number of factories being thirty-four, employing fifty-three thousand people—men, women, and children.

The great bulk of the factories are in Lombardy, and it is notable that many of the proprietors are German, French, and English. Some of the firms have established a kind of training school in connection with their establishments, from which they fill up vacancies, or commence new extensions.

In the section of useful arts was a long gallery, containing a fine collection of art furniture. The suites of oak, ebony, and inlaid furniture, were much admired.

The display of "ceramics" showed a revival of the art in Italy. Many of the specimens of painted and enamelled ware, and also the imitation of the antique, were excellent. The clay modelling was greatly admired, both for its detail and finish. There was a large show of varieties of glass, but the poorness of the "metal" did not do justice to fine samples of "cutting" which were exhibited. The venetian glass from Dr. Salviati's works attracted great attention, more particularly the Mosaics in this department, which were shown in all the states of manufacture.

The Fine Art Department was held in a separate building, and was divided into the three classes of painting, sculpture, and architecture.

The "Zoo-technical" Exhibition was held in a building specially constructed for it, on the bastion of the city, in the vicinity of the main building, and in this horses, cattle, dogs, and poultry were successively shown.

INDIA-RUBBER IN THE UNITED STATES OF COLOMBIA.

A very considerable trade is carried on in Colombia in gathering india-rubber, and the trade accounts of that country show a large increase in the export of this article for 1880 over the previous year, the greater part of it being consigned to the United States.

Consul Smith, of Carthagena, in his recent report, gives an interesting account of the system pursued by the rubber hunters in collecting this article, and, at the same time, calls attention to the wasteful custom they have of cutting down every tree from which they extract the rubber instead of tapping them; in this way all the trees near the rivers have been long since destroyed, and the hunters have now to go several days' journey into the forests, crossing swamps and mountains before they can find the rubber and bring it out on their backs over these rough trails. Each succeeding year the quantity gathered is less, and it is a matter of surprise that the Colombian Government has not enforced its regulations against the systematic destruction of one of the most valuable forest trees. The trees which yield the largest supply flourish along the banks of the Sinu and Aslalo Rivers. The hunters before entering the woods, provide themselves with guns, ammunition, flour, salt, and tobacco. The flour is made from plantains, which are cut into slices, dried and ground, and is generally mixed with corn meal; this will keep sweet for months. For meat the hunters depend upon the game they can kill. Each man starts out with his gun and machete alone, hunting for rubber and game. As soon as a rubber tree is found he cleans a space round the trunk, cutting away all vines, underbush, &c., and again marches on in search of more rubber trees, not returning to camp till nightfall. According to immemorial custom, a tree belongs to him who has cut round it. The hunt is continued until all the trees in the vicinity of the camp are thus secured, and then begins the work of gathering the rubber. A hole is dug in the ground near the rubber trees, unless another party is encamped near, in that case the holes are dug near the camp. The bark of the tree is first hacked with a "machete" as high as a man can reach, the cuts being in the form of a V, and the milk, or sap, collected as it exudes, and put into the hole which has been dug for it. After the sap ceases to flow from the cuts, a pile of wood or brush is made at the foot of the tree, and the tree itself is chopped down, the branches keeping one end of the tree off the ground, and the piles of wood at the foot of the tree doing the same at the other end, thus the tree is suspended. The hunter, after carefully placing large leaves on the ground under the tree, proceeds to cut gashes in the bark throughout its whole length. The sap is collected from the tree and from the leaves placed under it, and added to the milk first collected. The sap when it first exudes from the tree is as white as milk and as thick as cream, but it soon turns black on exposure to air and light, if not properly watched and cared for. The quantity of milk which is put into one hole, depends not only in the size of the trees, and their distance apart, but also on the strength of the man who is to carry the rubber from camp to the rivers, and the track and trail he must carry it over. As soon as all the milk is placed in the hole, the rubber is coagulated by the addition of some substance, such as the root of "mechvacan," hard soap, or other substances, and these cause the milk to coagulate so fast as to prevent escape of the water, which is always present in the fresh sap, and as the rubber and water will not mix, a piece of rubber coagulated in this manner is full of small cells containing water. It costs no more to make the rubber perfectly clear and transparent as amber, in which case it is infinitely more valuable, than to make it full of holes, water and dirt. As soon as all the rubber trees are cut down, and the rubber coagulated, the pieces are strapped on the backs of the hunters, by thongs of bark, and carried by them out to the bank of the river, and brought to market by canoe or raft. Consul Smith says, in concluding his report, that the importance of the india-rubber tree, in connection with the many and useful purposes to which it is now applied, can hardly be estimated, and that the attention of the planters of Colombia has never been turned to its cultivation, and he expresses an opinion that a good field for investment lies in this direction, as a plantation of india-rubber trees would prove a most valuable source of profit. There are places on the Sinu river where the trees will grow from eight to ten inches in diameter in three or four years from the planting of the seed; the trees require but little attention, and begin to give returns as soon, if not sooner, than other trees.

SMOKE ABATEMENT EXHIBITION.

The international exhibition at South Kensington of grates, furnaces, and other appliances for the scientific consumption of fuel, formed by the National Health and the Kyrle Societies, was opened on Wednesday afternoon (30th ult.), by the Lord Mayor. Before the opening of the exhibition, a meeting was held in the Albert-hall, under the presidency of the Lord Mayor. Her Royal Highness the Princess Louise and the Marquis of Lorne were present, and the company filled the entire area of the hall. The report of the committee was read by Mr. Ernest Hart, who gave a detailed account of the circumstances which led to the exhibition, and of the manner in which the work of the two societies had been supported by public opinion and by the evidence of scientific men. The committee claim for the exhibition that it will tend directly to promote the better utilisation of coal and coal products, and that it will afford trustworthy information upon which a sufficient amendment of the existing law may be based.

The MARQUIS of LORNE moved the adoption of the report, which was seconded by Mr. SHAW-LEFEVRE, who said it was no easy matter to know what ought to be done, especially as the authors of the mischief were not so much the chimneys of manufactories as the private grates, of which as many as 800,000 were lighted in London every morning. He could only hope that for these offenders many of the smokeless grates in the exhibition would be satisfactory and popular substitutes.

Lord Aberdare said it was impossible to draw an indictment against a whole nation. The more practical plan was to show the possibility and the advantage of reducing the production of smoke; and then, when smoke-consuming grates as cheap as those now in use could be supplied, the gradual application of compulsion might be considered. He feared that no real reform would be effected by moral suasion; indeed, the whole history of smoke legislation was a proof to the contrary. In the metropolis, it was true, the law was carried out, but in other parts of England the supineness of the municipal authorities showed the ineffectual character of permissive legislation. He suggested that, given the success of the efforts of the committee, an Act of Parliament might be passed that henceforth no houses should be built without grates designed to consume their own smoke; and Parliament might further order that no grates of the old pattern should be supplied after a certain date.

The Exhibition fills the two arcades leading from the conservatory of the Royal Horticultural Gardens. It includes a great number of improved fire-grates, furnaces, kitcheners, cooking, warming, and other apparatus, devised to prevent smoke or to consume smokeless fuel; together with varieties of bituminous and anthracite or smokeless coal, and special fuel for household fires; and arrangements have been made for the testing of the apparatus exhibited. The exhibition, which consists of domestic and industrial appliances, is roughly divided into six sections, of which the first contains open coal fire-grates, stoves of all kinds, kitcheners, and kitchen ranges; the second, gas-heating apparatus of all kinds; the third, hot air, hot water, and steam appliances; the fourth, gas-engine, boiler furnaces, and appliances for steam-engine and general industrial purposes; the fifth, anthracite, bituminous and semi-bituminous coals; and the sixth, all foreign exhibits, amongst which are contributions from the United States, France, Germany, Holland, Belgium, Sweden, and Canada. It is proposed to award certain prizes and medals to the best exhibitors. Among the donors for this purpose is Dr. Siemens, who has offered a prize of 100 guineas. A ladies' prize of 100 guineas, divided into two sums, for the best domestic open grate and best kitchener, will be given. The Council of the Society of Arts have offered a medal; the Manchester Association for Controlling the Escape of Noxious Vapours have added a prize of £50; and further prizes will also be offered.

Correspondence.

KITCHEN BOILERS.

In the correspondence on this subject, I have not seen any allusion to the old but excellent plan of deriving the high-level hot-water supply from an inner vessel not in direct contact with the fire, instead of from the boiler itself. It is so simple, and so free from the objection of requiring periodical attention to insure its working, that you will do good service by bringing it to your readers' notice.

If "F. B. W." will convert his high-pressure into a low-pressure boiler, by giving it a loose cover instead of a fixed one, and will then connect his pipes with a coil of piping (or any other convenient form of closed vessel) plunged in the boiler, he may for the future enjoy a sense of perfect security against explosion, even if the pipes should freeze or the boiler become incrusted.

A. L. Newdigate.

25, Craven-street. W.C.

General Notes.

Synchronized Clocks.—These clocks were exhibited at the Society of Telegraph Engineers, not by Messrs. Barraud and Lund, but by Messrs. Lund and Blockley, who have synchronized the clock in the meeting-room of the Society of Arts on their system.

International Exhibition in New Zealand.—An International Exhibition will be opened at Christchurch, on March 18th next, and a special section is to be devoted to the exhibits from Great Britain. Gold, silver, and bronze medals will be awarded. Particulars respecting the Exhibition can be obtained at the International Exhibition Offices (Messrs. J. M. Johnson and Sons, Limited), 1, Castle-street, Holborn.

Errata.—Prof. Silvanus Thompson sends the following errata for his paper in last week's *Journal*:—Page 32, col. 1, line 9, *for* 10,000, *read* 100,000; page 32, col. 2, line 31, *dele* and; page 34, col. 2, line 1, *after* lead, *insert* Litharge, or yellow oxide of lead; page 34, col. 2, line 24, *for* circumstances, *read* substances; page 35, col. 2, line 6 of footnote, *insert at end of line*, "quantity of electricity conveyed in the;" page 36, col. 1, line 46, *for* 1869, *read* 1860; page 36, col. 2, line 33, *for* film, if, *read* films of; page 37, col. 1, line 8, *for* pressure, *read* presence; page 37, col. 2, line 8 from bottom, *for* recent, *read* real; page 39, col. 2, lines 3 to 5, *for* 4·983, 3·450, and 11·329, *read respectively* 4,983, 3,450, and 11,329; page 39, col. 2, line 5 from bottom, *for* change, *read* charge; page 41, col. 1, line 19 from bottom, *for* 25, *read* 23; page 41, col. 2, lines 22 to 25 from bottom, *for* 3·75, 12·85, 3·28, and 10·76, *read respectively* 3,750, 12,850, 3,280, and 10,760; page 41, col. 2, line 8 from bottom, *for* 20, *read* 30; page 44, col. 1, *insert* between lines 24 and 25, "higher temperature than can be obtained by a cell of."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Friday Evening at Eight o'clock :—

December 2.—Meeting for the Discussion of the Society of Arts' Patent Bill. The chair will be taken by Sir James Fitzjames Stephen.

Wednesday Evenings at Eight o'clock. For evenings before Christmas :—

December 7.—"Combination System of Steam Heating for Towns and Villages." By Capt. Douglas Galton, C.B., F.R.S. Dr. Siemens, F.R.S., will preside.

December 14.—"Electric Lighting at the Paris Exhibition." By W. H. Preece, F.R.S.

For Meetings after Christmas :—

"Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. Burton.

"Stained Glass Windows." By Lewis Foreman Day.

"Photometric Standards." By Harold Dixon.

"Telephonic Communication." By Lieut.-Col. C. E. Webber.

"The Causes and Remedies of Bad Trade." By Walter R. Browne, M.A.

"The Native Tribes of the Hudson's Bay Territories." By Dr. Rae, F.R.S.

"The Manufacture of Ordnance." By Colonel Maitland.

"Some Practical Aspects of Recent Investigations in Nitrification." By R. Warington.

"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. Emerson Dowson.

"Gas for Lighthouses." (Illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses.) By John R. Wigham.

"The Relation of Botanical Science to Ornamental Art." By F. Edward Hulme, F.L.S., F.S.A.

"The High-pressure Steam-engine." By Loftus Perkins.

"The Industrial Resources of Ireland." By G. Phillips Bevan.

"A New Antiseptic Compound, and its Application to the Preservation of Food." By Prof. Barff, M.A.

"Tonnage Measurement." By Admiral Sir R. Spencer Robinson, K.C.B., F.R.S.

"Tools and Cutting Edges." By D. A. Aird.

"The Teaching of Forestry." By Colonel G. F. Pearson.

"The Art of Turning." By P. W. Hasluck.

"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By J. L. W. Thudichum., M.D.

"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. Thomas, F.C.S., and Percy C. Gilchrist, F.C.S.

"Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By William Cochran.

"Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. Henry Noel Shore.

Foreign and Colonial Section.

The Meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 31; February 28; March 21; April 4, 25; May 23.

Applied Chemistry and Physics Section.

The Meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock :—

January 26; February 23; March 9, 23; April 27; May 11.

Indian Section.

The Meetings of this Section will take place on the following Friday Evenings, at Eight o'clock :—

February 17; March 17, 31; April 21; May 12, 26.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The First Course, on "Some of the Industrial Uses of the Calcium Compounds." Four Lectures, by Thomas Bolas, F.C.S.

Lecture III.—December 5.

Sulphate of lime and its occurrence in nature. Gypsum and alabaster. Plaster of Paris, its preparations and uses. Physical and chemical aspects of the setting of plaster. Accelerating and retarding influences. Scientific principles involved in some of the applications of plaster. Moulding, stereotyping, and other processes.

Lecture IV.—December 12.

Other calcium compounds and their uses. The phosphorescent sulphide. Lime soaps. Bleaching powder. Phosphates of calcium. Organic calcium salts. The hardness of water, &c.

The Second Course will be on "Recent Advances in Photography." By Captain Abney, R.E., F.R.S.

January 30; February 6, 13, 20.

The Third Course will be on "Hydraulic Machinery." By Prof. John Perry.

March 6, 13, 20, 27.

The Fourth Course will be on "Book Illustration, Old and New." By J. COMYNS CARR. April 20; May 1, 8, 15.

JUVENILE LECTURES.

The two Juvenile Lectures will be by W. H. PREECE, F.R.S., on "Recent Wonders of Electricity." The dates for these are Wednesday evenings, December 28 and January 4. The lectures will commence at 7 o'clock. Special tickets will be issued for these lectures.

ADMISSION TO MEMBERS.

Members have the right of attending all the Society's Meetings and Lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* to the Cantor and other Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 5... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "Some of the Industrial Uses of the Calcium Compounds." (Lecture III.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Dr. Voelcker, "Agricultural Experiments; how to conduct them."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Mr. E. P. Squarey, "Land Legislation and Tenants Improvements." 2. Mr. P. D. Tuckett, "The Cause of the Failure of the Agricultural Holdings' Act of 1875, and the Present Agitation for Protection for Tenants' Capital."

British Architects, 9, Conduit-street, W., 8 p.m. 1. Major Bale, "Native Buildings at the Gold Coast." 2. Mr. R. Phené Spiers, "The Works of the late Major Mant, R.E."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. The Rev. W. D. Ground, "On Herbert Spencer's Theory of the Will."

London Institution, Finsbury-circus, E.C., 5 p.m.

TUESDAY, DEC. 6...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. William Henry Wheeler, "The Conservancy of Rivers; the Fen District of England."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m.

WEDNESDAY, DEC. 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain Douglas Galton, "The Combination System of Steam Heating for Towns and Villages."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS). 11 a.m., General Meeting. 1 a.m., Annual Meeting.

Geological, Burlington-house, W., 8 p.m. 1. Rev. W. Downes, "The Zones of the Blackdown Beds, and their Correlation with those at Haldon, with a List of the Fossils." 2. Mr. P. H. Carpenter. "Some New or Little-known Jurassic Crinoids." 3. Mr. G. R. Vine, "Notes on the Polyzoa of the Wenlock Shales, Wenlock Limestones and Shales over Wenlock Limestones."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. W. A. H. Naylor, "The Fruit of Omphalocarpum Procera." 2. Mr. J. B. Barnes, "The Antiseptic Properties of Cinnamic Acid." 3. Mr. E. M. Holmes, "Note on Hedyosmum Mutans and Critonea Dalea."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Rev. Dr. Hooppell, "The Discovery of the Ruins of a Saxon Church in Gosforth-park." 2. Mr. E. P. Loftus Brock, "Excavation of the Site of Carrow Abbey by Mr. J. J. Colman, M.P." 3. Mr. Thos. Morgan, "Result of the Great Malvern Congress."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Sanitary Institute, 9, Conduit-street, W., 7¾ p.m. Inaugural Address by Dr. Alfred Carpenter, and announcement of the "Wyatt Edgell" Prize.

THURSDAY, DEC. 8...Royal, Burlington-house, W., 4½ p.m. 1. Dr. W. A. Herdman, "The Genus Culeolus." 2. Mr. W. K. Parker, "The Development of the Skull in Lepidosteus Osseus." 3. Mr. F. M. Balfour and Mr. W. N. Parker, "The Structure and Development of Lepidosteus. 4. Mr. P. F. Reinsch, "A New Mineral found in the Island of Cyprus." 5. Mr. Adam Sedgwick, "Certain Points in the Anatomy of Chiton." 6. Mr. A. Mallock, "The Action of Cutting Tools." 7. Mr. J. Milne and Mr. T. Gray, "Seismic Experiments." 8. Dr. G. Gore, "The Electrolytic Diffusion of Liquids." 9. Mr. G. F. Rodwell, "The Coefficients of Contraction and Expansion by Heat of the Iodide of Silver, the Iodide of Copper, and of five Alloys of these Iodides." 10. Mr. J. J. Thomson, "The Vibrations of a Vortex Ring; and the action upon each other of Two Vortices in a Perfect Fluid."

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m.

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. W. Spottiswoode, P.R.S., "The Polar Planes of Four Quadrics." 2. Mr. R. F. Scott, "Some Forms of Cubic Determinants."

FRIDAY, DEC. 9...Frœbel Society (at the HOUSE OF THE SOCIETY OF ARTS), 7½ p.m. Annual Meeting.

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, DEC. 10...Physical, Science Schools, South Kensington, S.W., 3 p.m.

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, DECEMBER 9, 1881.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. Thomas Bolas, F.C.S., delivered the third lecture of his course "On Some of the Industrial Uses of the Calcium Compounds," on Monday evening, 5th inst. The subjects specially dealt with were—Sulphate of lime, and its occurence in nature; gypsum and alabaster; plaster of Paris, its preparation and uses; the scientific principles involved in some of the applications of plaster; moulding, stereotyping, and other processes.

PATENT-LAW DISCUSSION.

The adjourned discussion on the Society of Arts' Patent Bill will be held on Thursday, December 15th, at eight p.m. Sir Frederick Bramwell, Chairman of the Council, will preside. Non-members should apply to the Secretary for tickets of admission.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

PATENT-LAW AMENDMENT BILL.

Friday, December 2nd, 1881; The Hon. Mr. Justice Stephen in the chair.

The Chairman said that meeting had been convened for the purpose of considering a Bill prepared by the Committee of the Society of Arts, and provisionally approved by the Council, in reference to patents for inventions. He need not remind them that this subject had been very long before the Legislature; and if any question had properly earned the title of being a vexed question, that was one, for Bills upon the subject had been introduced at least six or seven times in the course of the last ten years. What would be the fortunes of the present Bill he hardly knew, but, at all events, there was an importance attaching to the proceedings of that evening, because he was informed that the Council were very desirous of obtaining from persons interested in the subject a full criticism of the provisions of the Bill. His duty, in the first instance, was simply to ask the meeting to listen to a statement of the principles and leading provisions of it, by Sir Frederick Bramwell. He would only say, at present, that he was as favourable as any one could be to any legislation calculated to effect the object of securing those rights to patentees, which, in his opinion, it was highly desirable, in the interest of the community, they should possess. With regard to the present Bill, there was a part of it to which he could not assent, but he would defer any criticism upon it until later.

Sir Frederick Bramwell, F.R.S., said it was not perhaps unreasonable that he, having been chairman of the Committee which prepared the Bill, should open the discussion. The subject was of great importance, and if there could have been any doubt on the matter, the fact that Sir James Stephen had been good enough to attend to preside over the meeting, would itself show that the subject did deserve the attention of those interested in the manufactures of the country. They were not met there to discuss whether there should be a Patent Bill at all. It was now nearly seven years since Sir James Stephen presided there on an occasion when a paper was read, and elaborately discussed, as to the expediency of protection for inventions, and the result of that discussion was to elicit from the newspaper press, and from the public generally, an almost universal expression of opinion in favour of the necessity of such protection; and indeed the proceedings in successive Parliaments showed that the Government itself was of opinion that a Patent Bill was needful. Not to go farther back than 1875, they had had Bills in 1875, 1876, 1877, and 1879, and they were now told that a Bill was to be prepared in the coming Session; therefore he trusted the speakers would confine themselves that evening to the provisions of the Bill that should be passed, and not go into the broad question whether there should be a Patent Bill at all—for the present purpose, that might be taken as conceded—and they should confine themselves to the question of what should be the nature of the Bill. He feared the discussion would be a very dry one, because he trusted it would not go into the rights of inventors, or into the interests of the oppressed genius, or anything of that kind, but would be confined to the bare question of expediency. He was sorry to say that there appeared to have been in time past, in the minds of those who framed Patent Bills, an impression that on the one side stood the inventor, as the natural enemy of the public, who were on the other side, and were to be protected by the Patent Bill; but that feeling, he hoped, had entirely disappeared, and he thought there was now a general feeling that any proper Bill must be one in the interest of the community as a whole; and that the interest of the public and of the inventors was the same interest, when properly understood. As the Chairman had said, this Bill had been provisionally approved by the Council; it had been prepared by a Committee of the Society, having for its members gentlemen who were entitled to some amount of attention, when they applied themselves to a matter of this kind. The Committee was composed of Dr. Siemens, Mr. Perkin, Professor Abel, Mr. Perkins, Mr. William Carpmael, Sir Henry Cole, Captain Douglas Galton, Mr. Trueman Wood (the Secretary), and himself. They had devoted themselves assiduously for months to the preparation of this Bill, and they had had the assistance of one of the most experienced draftsmen. But since the Bill was prepared, the Committee had not been idle, but had themselves proposed to amend their own production, and a revised print had been circulated in the room. Before concluding his introductory observations, he would call attention, briefly, to the few particulars in which the Committee had altered the Bill. With respect to the Bill as a whole, he would say, in the first place, that it consisted of four parts—the first relating to the granting, amendment, and prolongation of patents; second, to the trial of patent actions in England; third, general provisions; and the fourth, transitory provisions. The third and fourth parts were merely formal, and the first and second were, he thought, the only parts about which discussion would seriously arise. In framing the Bill, two principles had been borne in mind; first, that so far from its being a bar to the development or improvement of an industry that the invention to which the improvement related should be in the hands of an owner, it was absolutely the only means by which an invention could be introduced. So long as the invention was free and open property, it was worth no one's while to take it up. He had said that very often in that room, and in the discussion of 1874 the whole matter had been fully gone into. All those who had had any experience of working patented inventions, would agree that where there was no property in the invention, any man who had machinery employed in carrying out a manufacture according to the old process would not seek to make that machinery useless, to discard it, and to introduce new machinery for a new process, which might or might not answer, because he knew he would be at the cost of the whole experiment; his competitors would stand by and see what he was doing; if he did not succeed, they would laugh at him; and if he did, they would copy him, and have the benefit of all the experience he had laboriously and expensively bought. Therefore, it was, that unless there was some one person having a property in the invention, who went about urging manufacturers to use it, tempting them by suggestions of participating in the benefits of the patent, or something of that kind, you could not get an invention thoroughly developed. He might pirate an expression of Dr. Siemens's, which he had used more than once, but he believed that it required reiteration to get any truth into the public mind. Dr. Siemens's way of putting it was this, that in his view, it was in the interest of the public, if an invention were found lying in the gutter that it should be taken up, and an owner assigned to it, in order that it might be worked. Therefore, instead of framing a Bill in the way in which former Bills were framed, which appeared to be on the ground of giving a patentee his patent in order to induce him to publish his specification, and then, having done that, to take every opportunity of tripping him up and depriving him of it, for, as was supposed, the benefit of the public—they had proceeded on the view that the patentee should have his patent, that he should be bound to make it clear to all who read the specification; but if in the outset he had failed to do so, there should be ample means of amendment, that that should be matter of right, and not of favour, and that in that way the patentee should be protected in his invention. He would call attention to one provision, which no doubt was of a startling character, and which he was not at all sure met the approbation of the Chairman, but the Society earnestly desired a full discussion, and although Sir James Stephen told him that he did not, as at present advised, agree with a good many parts of this Bill, the Committee still begged of him to come and preside, as they did not want a one-sided discussion, and they should be happy to hear all that could be said, either against the Bill or in its favour. It was suggested by this Bill that what he might call a dormant publication should not prevent a man having a valid patent. At present, if there existed some book in the British Museum, no matter how old, how unknown, that was a publication within the meaning of the Patent Act, and if any persons brought forward an invention which might be found in that book even only imperfectly described, though he spent his time upon it and developed it for the good of the community, he would be liable to have his patent taken from him, because there was to be found in one of these libraries a book containing a statement of the invention, although it was lying utterly dormant and useless. The Committee thought that if a generation were suffered to pass away from the last publication of any book, and no use had followed on that publication, then it would be for the interest of the community that a person should not be deterred from patenting that which might happen to be in that book, from having it as his property, in order to induce manufacturers to use it. A clause was introduced, therefore, which provided that after the lapse of 30 years from the publication of the last edition of any book, if it could not be shown that the invention had been used, that book should not be treated as a publication which should invalidate the novelty of the patent. The next way in which they showed their belief in its being desirable that patents should be property, was in respect to foreign patents; there, he might say, they were following the Bill of 1879, as they did in many of its clauses. That Bill of 1879 was a great improvement on any that preceded it, though there were several points which they thought might be amended. Although a Committee of the British Association had petitioned the Home Secretary about it, with a view to its amendment, they nevertheless said that if the framers of it would not amend it, they would prefer to have it as it stood, rather than not have it at all; but the Committee of the Society of Arts had their own Bill, which they preferred to that of 1879. However, in this matter of foreign patents, they were only following the Bill of 1879, which provided that no foreign inventor, or an inventor in the Colonies, should be ousted of his patent in England, because there might be deposited within the walls of the Patent-office a copy of the foreign or colonial specification, so long as he applied for the patent within twelve months of the publication in the foreign country. The next thing was, that they proposed, if a patent were not granted, the provisional specification should be destroyed, and they did so on this ground. At the present time there were many provisional specifications containing good ideas, amounting, it might be in some cases, to absolute disclosures, where the patentee had not proceeded and obtained the seal, either because he was too busy or was forgetful, or for some other reason, and thereby, when at the expiration of six months the provisional specification was open to everybody to read, it barred a person from taking out a patent for the same invention, because it amounted to disclosure, although frequently an imperfect one. According to their view, the throwing open of the provisional specification to the public might render wholly worthless an invention which might have been the subject of a patent and, becoming some one's property, might have been developed into an industry. He had before cited a case that had occurred to himself, which he might repeat as an illustration. Some time ago he made an invention for making chain cable without weld. He caused search to be made before he applied for a patent, and in a provisional specification he found such a disclosure as would have prevented his obtaining a valid patent for the substantive invention, and would leave to him only a patent for some special means of carrying out the manufacture, and accordingly he proceeded no further. That was now some fifteen years ago, but he had never heard of anybody making these weldless chains, although there was a specification ready to the hands of anybody who chose to go and take it up. According to their judgment, such provisional specifications being made public did harm, and not good, because it prevented an invention being patented and developed. Then, again, they proposed to limit opposition to cases of fraud. They did not see why an intending patentee should be opposed by a variety of persons, simply because they thought the patent would interfere with them in their business. Then with regard to the power of amendment; they proposed that there should be not merely amendment by way of disclaimer, but amendment by way of further claim, of matters which were not claimed in the original specification, but which might have been claimed if the patentee had known better at the time. With regard to the destruction of provisonal specifications and to amendments, the original print had been altered. With respect to prolongation, they proposed that the Crown should not be entitled to oppose on behalf of the public (as it was facetiously called), as it did at present, unless the Crown were interested as a manufacturer. They proposed also following the Bill of 1879, that a patent should bind the Crown, but with a provision that that should not interfere with the public safety in warlike matters. Again, in actions for infringement; at the present time, if a patent contained two heads of invention, *A* and *B*, and a man had infringed *A*, it was an answer to the action if he said, I agree I have infringed *A*, which I agree is useful, and there is nothing the matter with it of any kind, but you have in the same patent, *B*. Now *B* is not new, or it is not useful, or anything you may please which may be urged against the validity of the patent, and thereupon the infringer is entitled to say, "although I have had nothing to do with *B*, although the infringement extends only to *A*, it is an answer to the action against me, that *B* is bad." They did not see why that should be so, or why, because the law allowed, to prevent double expenses, that a man should put into his patent two things, *A* and *B* being cognate matters, properly included under one title, that a man who took *A* should be able to save himself because *B*, which he did not take, was bad. They therefore confined the pleas of the defendant in any patent action to that part which had been infringed, and did not allow him to direct any of his pleas to heads of invention which had not been infringed. That was section 60, in which there had been a slight alteration made, and two pleas had been added, since the Bill was printed. In the foregoing matters, they had been guided by the principle he had laid down, that it was for the interest of the community as a whole that there should be property in inventions. He now came to a matter which might be said to be somewhat in the other direction, and that was, they provided that there should be, under certain conditions, obligatory licenses. They certainly provided it in the case of the Crown, because, as for the first time the Crown was made subject to patent right, it was clear the national defences should not be hampered by the Crown being unable to use a patented invention. In that case they provided for an obligatory license, following again the Bill of 1879; but that Bill contained a condition which appeared to them to be extremely grievous. Beside compelling the patentee to grant licenses not only to the Crown but to persons generally, in a certain state of events, it also made it obligatory on the patentee to put his invention to work to a considerable extent within three years from the granting of the patent, failing which, the patent was to be revoked. A deputation from the British Association represented to the then Attorney-General that when there was a provision for obligatory license, there would be no need of this "putting to work" provision, and they gave many instances of cases where it would be impossible for a man to get an invention put to work within three years, instances of inventions of such magnitude, and affecting interests so valuable, or to be employed where human life was concerned, that it was only with great difficulty, and after years of insistance, that such patents could be put to work at all. They therefore expunged from the present Bill that provision which related to the revocation of the patent, thinking that a provision as to obligatory licenses, under certain conditions, ought to satisfy everybody on that head. With respect to the term, they proposed 17 years, the term of the United States. The Government Bill of 1879 proposed 21 years, with no power of prolongation, but they found that 21 years was strongly objected to by many of the manufacturers in the North, who said that a good patent ought to remunerate the owner in 17 years, and that 21 years was too large a slice of a man's life to be debarred from using a particular invention. But they proposed to leave power of prolongation. At the present time, the duration was 14 years, with power to prolong to as much as 14 more, a power very rarely, in fact hardly ever, exercised. The common prolongation was for 7, 5, or 3 years, as the case might be. They proposed to make the term of a patent 17 years, with a power of prolongation to 11, leaving, therefore, the maximum time 28 years, as at present. It appeared to them far more reasonable, instead of giving every patentee a patent for 21 years, which in cases of a highly successful patent would give a very large remuneration, that the general time should be shorter, but that there should be the means of relief by prolongation to those who, from various causes, had not been able to bring their inventions to profitable use before the time of expiration. The only objection to prolongation he had ever heard was the unsatisfactory manner in which these petitions were dealt with. At the present time, although there was no law on the subject, there was an unwritten rule that if a patentee had made £10,000 in the course of 14 years, no matter what the value of the invention might be, he was to have no prolongation. He did not say it was never broken through, but he did not think it had been of late years, and he was sorry to say that in that £10,000 was included not merely the revenue derived from royalties, but the trade profits of the manufacturer where he manufactured under his own patent. There was no allowance for the expenditure of his own time, but he had to merge his ordinary trade profits into the royalty, and £10,000, no matter what the invention, was looked upon as the limit of his reward, that is something like £700 a year for 14 years was deemed adequate for the most important invention. Then again, if his application were unsuccessful, he not only had to pay his own costs, but the costs of his opponent. That was a kind of tribunal which they thought might be very well improved, and they proposed, by their Bill, to have a tribunal, which he hoped would do away with the hardships now attendant upon petitions. With respect to fees, that was a very vexed question indeed. They had adopted the fees of the 1879 Bill, modified in so far as necessary to make them accord with the 17 year term. There was a great deal more to be said, but that was all with which he would now trouble them, so far as regards that part of the Bill which related to the benefit to be derived by the public from an invention being in the hands of an owner. With respect to the other portion, namely, that a Patent Bill was not of necessity, and indeed had better not be, within legal domain, with all deference to the Chairman and many others, he must say that he saw no necessary connection between the law officers of the Crown and patents. He was glad to think that the present Government appeared to be somewhat of that opinion, inasmuch as, for the first time, the intended Government Patent Bill, instead of being prepared either by the Lord Chancellor or by the Attorney-General, was to be prepared by the President of the Board of Trade. He looked on that as a recognition of the fact that patents did concern the great manufacturing interests of the country, and should not be considered as matters of legal technicality. It would be seen that in the Bill now before the meeting, it was proposed that there should be a real working Board of Commissioners, composed of one engineer of experience, one chemist of experience, and one lawyer of experience, and they proposed that these Commissioners, and not the Lord Chancellor, or any of the law officers, should be the persons for examining, as the Bill provided, into the applications for patents; the persons to grant patents, to consider questions of amendment and questions of prolongation. Now, he came to the second part of the Bill, where they had taken steps which he knew did not meet the approval of the Chairman, and which he knew did not meet with the approval of many men whose opinions were entitled to the utmost respect, namely, the suggestion that patent actions should not be tried by the ordinary Law Courts, but by the Commissioners in the way provided. They proposed that the Commissioner—not the lawyer, but the chemist or engineer, as the case might be, to whom the subject matter of the patent more immediately belonged—aided by a legal assessor (not the legal Commissioner) to guide him in the rules of evidence, and matters of that kind, should be the court of first instance to hear the litigants. They proposed also that, if need be, he should go down to the spot, to save the parties the expense of coming to London; that he should hear the complaint and should determine upon it; and if either party desired to appeal, the appeal should be made (and about this there had been great discussion in the Committee), to the three Commissioners. He did not think it would be said that they were appealing from one tribunal to the same tribunal. In the ordinary Law Courts, it was no uncommon thing for the Judge of one Court to have his judgment appealed from, and considered by his brethren on the Bench. They thought that patent actions conducted in that way would be conducted very simply, and at very little cost. It must be remembered that a great part of the expense of patent actions was in the making of models, which should teach, first of all, the counsel, and then the judge, and through him the jury, the very alphabet of the invention. He had said it before, and would now repeat it, although it had not been well received, that men might be of great intelligence and of very great culture, and yet be unable to "read" a mechanical drawing. They could not follow the uncoloured, perspectiveless drawing, and this was not unreasonable. There was nothing to show which represented void spaces, and which solid material, and he knew it was extremely difficult for a man unused to it to read a mechanical drawing. Thus you had to render into models, for the information of those who could not read a drawing, the things which to mechanics were as legible as was an ordinary map to an educated man. He must say that if the litigants in a atent action could insure such a tribunal as their Chairman, he should desire none better, as he possessed a thoroughly appreciative mind for mechanical subjects, and he hoped he might be allowed to give an instance of his remarkable powers. They were on one occasion at Nottingham together, and Mr. Fitzjames Stephen (as he then was), told him he had never seen a lace manufactory, and asked for an introduction to one. He gave Mr. Fitzjames Stephen an introduction, and about a week after, received a letter from him, in which he gave in a most lucid and succinct manner a complete account of the operations of a Lever's lace-making machine. Now, he knew many machinists and accomplished mechanics who, being turned loose into a room where there was a Lever's lace-making machine, would come away at the end of an hour with a very bad head-ache, and only a confused impression of a whirl of wheels; but their Chairman was not in that condition; he not only understood what he saw when he saw it, but he had it so much in his mind that he could give a full and clear description of it when he came away. But such powers were exceptional, and were very exceptional in a person not trained to the study of mechanism. They wanted, if possible, to always make sure of having patent actions tried by persons who, by their education, were competent to deal with them. With respect to the appointment of a special tribunal, they had a precedent in the Railway Commissioners, who were appointed to try disputes between railway companies, and between railway companies and their customers. He did not know that there was anything in those disputes which a judge and jury could not grasp, but, nevertheless, it was thought expedient to provide a special court for them. Now, if it were necessary to provide a special court for the trial of such cases, surely it was desirable to use for the trial of patent actions the Commissioners whom they hoped to see appointed for the other purposes of the Bill. He would not occupy the time of the meeting longer, except by drawing attention to the alterations which had been made in the Bill since it was printed, and which were marked in the revised prints by black lines against the altered sections. In the first place, there was an amplification of the statement as to what should amount to publication; then there was, in section 7, the introduction of a few words to cure what was thought to be a defect in the original, viz., that it might be held to apply only to original documents, and not to copies. Then, again, whereas it had been formerly proposed that the provisional specification should be destroyed, even if the patent were granted, they now considered that as amendments might include further claims, it would be necessary to refer to the provisional to see whether such claims were originally covered by it. They therefore proposed that the provisional specification was only to be destroyed in cases where a patent was not granted, and that where it was granted the provisional was to be preserved for the information of the Commissioners. There was another amendment in the clause relating to endorsed patents. In section 23 there was an amendment, the object and effect of which he would endeavour to show by the following supposititious case. Supposing in a patent for improvements in a steam-engine, the provisional specification described an improved governor and an improved feed-pump, but that in the complete specifications only the governor was claimed, leaving the feed-pump unclaimed, and that someone, seeing it was not claimed, manufactured the feed-pump. At any time afterwards it was competent to the patentee to amend his patent by making the feed-pump the subject of a further claim. But it would be a very hard case indeed, if the persons who had gone to work making that which was not originally claimed, and who might have been doing so for some years, should be interfered with, and therefore it was now provided that these persons should be at liberty to continue their manufacture as though this new claim did not stand part of the patent. Then, in section 29, there was an amendment with regard to the granting of licenses by the Commissioners on the patentee's behalf, preserving the rights of existing licenses. Then by section 36 it was provided that when an opponent to a patent convinced the Commissioners that the application was in fraud of the opponent, the opponent might, if he pleased, take the patent as of the same date, in fact, step into the shoes of the applicant. In those cases where a patent had been granted, and where the patentee insisted on having it adversely to the report of the examiners, and it had been endorsed by them with an expression of opinion that it was subject to defects of a certain kind, it was not desirable that a patent action arising on such a patent should be tried by the Commissioners, who had already expressed a strong adverse opinion; therefore section 57 had been altered so as to leave persons who had "endorsed" patents to bring their actions in the ordinary Courts. Then section 60 gave the pleas which were to be allowed to defendants in a patent action, and they had added two pleas to those at first inserted; one was that the defendants might plead "leave and license" from the owner of the patent, and the other was that the patent was obtained by reason of a further claim, and that the defendants had used the patent prior to the further claim being allowed. He had now exhausted the alterations, though he had by no means exhausted all he desired to say on this Bill; but he felt it was only right, in the interest of further discussion, that he should conclude now, though, as he was somewhat in the position of counsel for the plaintiff, he hoped he might be allowed a little right of reply, if necessary.

Mr. John Standfield said the point which he wished specially to draw attention to was that in relation to the fees, and particularly the payment of the fee at the end of the fourth or eighth year. He thought it would be a great improvement if it could be made an annual payment. An inventor might take out a patent and discover there was some defect in it, and might not care to work it, but the public had no means of ascertaining whether he had an interest or no for a considerable time. Now, if he were called upon to pay a small annual fee, it would clearly prove whether he had an interest in the patent or not. Another serious disadvantage was this. The Bill did not seem to be an International Bill, and they wanted a Bill which would be not only good in England, but in the Colonies and other countries, therefore, in order that it might be easily remembered when payments should be made, it would be much better to have an annual fee payable on the first of January in each year; then every inventor would remember how many patents he had, he would know whether he wished to keep them in existence or not, and could forward the fee to the office without having to employ a patent agent, any more than he had to employ an agent in paying his life or fire insurance. Their best thanks were undoubtedly due to Sir Frederick Bramwell and those who had drawn this Bill, but he hoped they would re-consider this matter. One other point was the examiners. It was absolutely necessary that they should have examiners, and he quite agreed if the examiners could determine what a patent should be granted for, they were competent to determine without any lawyers to whom the patent belonged. It certainly was not a question for lawyers more than examiners.

Mr. Alfred Newton had given this Bill very careful consideration, and he must certainly give the Committee who drew it up great credit for the care in which they put on paper the requirements, not only of patentees, but of the public. There were, however, some novelties of serious moment contained in the Bill, and if it were enacted in the present form he feared they would be landed in a disagreeable position. The first thing that struck him was that now for the first time, in a Bill for protecting inventions, they had a definition of what a patentable invention was. In the Act of James they had everything which was desired or desirable, "any manner of new manufacture." That definition had been amplified by the practice of some centuries, and they knew perfectly well what new manufacture was a patentable invention, and they knew what a new manufacture was, because they had all the decisions of the Law Courts to refer to. The advantage of not having a finely drawn definition was this, that as circumstances arose, and circumstances were ever changing with regard to inventions, the Law Courts provided a new interpretation to meet the requirements of the case; but however clever a definition they might have, that definition would, at some time or other, be insufficient for the purposes of the Act. A definition, to be a definition at all, must be contracting, and what they wanted was, an expanding statement. Again, the four definitions in the Bill, if retained, would give us one more than was needed, because the third was included in the second. Now came another point, which was more serious, that was with regard to the examinations of the applications. They were to have three Commissioners, and he knew not how many examiners. The three Commissioners, assisted by examiners, were what he had always contended for, but if these were competent, it seemed a strange thing they should not be able to say what was a patentable invention, and that they should have to allow a patent to pass for something which they said was not a patentable invention. Therefore, he thought they should have power to refuse a patent. Again, the provision in section 7 was that complete specifications should be filed at the end of six months, and be open to the public, but that they then should be brought under examination for two purposes; one to see whether the complete specification extended the invention beyond the lines of the provisional; and secondly, to see whether the claims appended to the specification were so intelligible that the examiners and Commissioners should understand them. As a patent agent, he objected to this clause.

Sir **Frederick Bramwell** said it was not the intention that the specification should be open to the public until the Commissioners had made their examination.

Mr. **Newton** said he was afraid the Committee had not considered what this examination of the specification entailed. There were now some 3,500 complete specifications filed annually, and when they had patents granted for £12 10s., they would be perhaps 15,000. But assuming they did not increase beyond 3,500, it would still be an immense labour. The reason for this comparison of the provisional or the complete specification was said to be this, that supposing a patent came into Court, there should be no plea needed or allowed that there was a discrepancy between the two. He had heard it estimated, and he believed it was near the mark, that there were in the course of the year nine actions in law on patents, and in order to save litigants from the cost of considering this small question, which really would cost nothing more than a few words of argument by the counsel engaged, there were to be 3,500 specifications examined at a cost of he did not know what. For his own part he had had within twelve months specifications pass through his hands that would require a very clever examiner indeed to master in three days, so as to say positively whether the provisional and complete specification agreed. With regard to the official examination of specification claims, to say that it would be torture to an agent was a mild term. Anyone who knew from experience what it was to get an American or a German patent through, would know what this meant. A specification was prepared with the greatest care, the client approved of it, and the expert, perhaps a chemist, or what not, approved of it too. The specification, in its complete form, was laid before the Commissioners, and submitted by them to an examiner, who, if he was a fair specimen of his class, was as thick-headed a man as you could possibly have, a man who would not care to understand it, except by reading the claims, and by merely reading the claims he defied him to understand it. To understand many a properly drawn claim you must go through the specification, and it required a competent person to put the proper meaning to the claim. The way in which this would act would be this, you must bring claims which were so clear and bald, that a typical examiner could understand them at a glance; but even that was not sufficient sometimes in the American office; they were obliged over and over again to twist and to turn the claims, until they thrust the thing down their throats, as it were. He was certain that the claims, if made clear to the office, would be most unsatisfactory to the patentee and injurious to his interests. He also objected entirely to the proposed method of trying patent cases. He had said that the three Commissioners or competent examiners were needed, not only for rejecting applications which ought never to receive a patent, but for other reasons; for instance, to enable patentees to know whether their inventions had been anticipated or not. But further than this, he believed that the Commissioners, and not the law officers, were the proper persons to consider all matters of contention relating to the granting of patents, and the amendment of specifications, either by disclaimer, or, as this Bill now proposed, because of new lights as to the value of certain unclaimed parts of the invention. But to go farther than that was undesirable. What they wanted, in trying a patent case, was a legal mind. He cared not where it was found, it might be in an engineer, or it might be in a chemist; but it was a most rare combination to find a legal mind in a scientific practical man. Unless you had a legal mind, you had a bias which was of a most inveterate kind. It was not that the mind was biassed to this or that person, but to this or that view, and you could no more alter that bias of mind than you could alter the features of the man. It required a legal training to deal with patent cases. There were occasionally men—he could point out a few, but only a few—who had no legal training at all, to whom he dared to submit such a question. But with these exceptions, he thought it would be most unwise to trust a matter of that kind to any but a legal mind. He thought the Commissioners should deal with the extension of patents also. His experience of the Privy Council as a tribunal, notwithstanding the satisfactory results of some applications, was that it was one of the worst tribunals that could be used for the purpose, and what Sir Frederick Bramwell had said against that tribunal was not the whole truth, but only a part of it. If any technical difficulty could be raised, they raised it to prevent an extension of the patent. So far from their saying £10,000 was sufficient, they would tell you that you had no right to come for an extension at all, because a patent in America would die out in a year or two, and then this extension would entail on the English public the payments of royalties, whereas in America they would pay nothing. Any matter of that kind not contemplated by the framers of the Act was quite enough to enable them to throw over with a good conscience an application for the extension of a patent.

Mr. R. E. **Webster**, Q.C., said he came there to listen and not to speak, but at the same time he was not unwilling to make one or two observations on this Bill. He should not venture on his own merits solely to address such a meeting, where there were so many men who had studied the subject so much longer than he had, but he might be permitted to say, especially in that room, that possibly his right to say something on this question was somewhat hereditary. Many there knew that he had had the privilege of being most intimately connected with one who for years had laboured in the matter, and to whose efforts amongst others, to a great extent a great step in this direction, namely the Act of 1852, was due. He admired exceedingly the tact and judgment with which Sir Frederick Bramwell had introduced this matter. He avoided very properly anything like a discussion of details, and had endeavoured to keep their minds on the principles of change which required most careful consideration. He might be allowed to add his small tribute as to the way in which this Bill had been prepared, for there was so much in it that was admirable, so much real improvement, that it was almost astonishing to find it all collected together in one document; still, he held it to be his duty, on a question that required free discussion, to point out, if he could, certain matters which he thought required further consideration, or which should not be accepted. He would call attention to some of these, although he could not hope to exhaust the subject. One or two things had been said by Mr. Newton in which he agreed, and he would, therefore, dismiss them in a word or two. He thought any fresh definition of subject-matter was unnecessary. He believed they wanted nothing more than the existing definition, viz., any manner of new manufacture which other persons, at the time of granting the patent, did not use. There had never been any real difficulty in understanding that definition; the only difficulty had been as to whether a particular subject-matter was new, or whether a particular subject-matter was the subject of invention, having regard to what had gone before it. He cordially agreed with Mr. Newton that if definitions of this kind were to be attempted, it would open the door to litigation, and might defeat the object in view; for he could see, even at the present time, that they might have some very nice cases on the question of what was any manufacture or any product, not being a natural product. He ventured to think it would be a wiser thing, *stare super antiquas vias*, and when they knew where they were, not to attempt to define subject-matter, in any more particular sense. He also agreed with the general provisions for the establishment of Commissioners, and for the examination of patents before they were granted. Anybody who had seen the practical working of the present inquiries of the law officers, must have come to the conclusion that it was unsatisfactory, and, therefore, he fully agreed that there should be examiners for the purpose of doing that work; but there was one thing which, though it did not quite come within the province of a lawyer, had somewhat surprised him; he was astonished to find that anyone should advocate the destruction of the provisional specification when the patent was not taken out. Were they so afraid, that they wanted to narrow the sphere of public knowledge? He could see the object in view, that a subsequent patent should not be defeated by the existence of an abortive specification, and there he went with them; but he would say, why not put into the Bill a provision that no mere publication of a provisional specification should of itself invalidate a subsequent patent; but not be so cowardly, he was going to say, as in the interests of other people to destroy that which might add something to the stock of knowledge. He cordially agreed with a matter of procedure to which Sir Frederick Bramwell had called attention, viz., the injustice of allowing a man who had taken invention *A.* to attack a patent simply because he said there was another part he did not want, which was perhaps useless, and defend himself for using *A*, because *B* was bad. He was glad to think that such a plea should be struck out of the rules of law, whatever might be the tribunals, and that a person should be confined to attacking that which he desired to take, and which he believed to be the substance of the invention. He also thought the provisions with regard to obligatory licenses, or licenses granted under certain circumstances, were admirable. He might say, in passing, that he thought there would be a great deal of difficulty in working that part of the Bill which said that an invention should be deemed to be new which had not been published within thirty years immediately preceding the application. He knew what was aimed at, and equally agreed that the object was laudable, but he was afraid it must be one of those risks which inventors must be content to run. He was not merely dealing with this question as being a difficult point to get through Parliament, but it would be very difficult to work. A book might have been written some forty or fifty years ago, and have lain dormant, but then the question would arise what reference had been made to that book in other publications, or should any reference to a book amount to the republication of the original book, and he thought they would again find themselves landed in very great dilemma. He only wished to call attention to the point, because he thought the framers of the Bill would have to consider further clauses, and that they might be able to protect inventors in a more practical way. He further agreed in the desire that a patent should be granted in this country to the real inventor, whether English or foreign, so that a stop might be put to sending across specifications sometimes in fraud so as to destroy the merits of real inventors who might bring their inventions to England. Having now noticed most of the minor points to which he desired to call attention, he came to one upon which the meeting would probably wish him to say a few words, and that was the establishment of this new tribunal. Of course he spoke from a lawyer's point of view, but he hoped that his position would justify him in saying that he spoke on this point from a perfectly disinterested point of view. Personally, he did not know that anything would suit him better than to have a body of Commissioners examining into these matters; but he did beg the inventors of England to pause before they consigned their interests to a fresh tribunal, or did anything to undermine that which he ventured to call the grand system of jurisprudence under which they had flourished in this country. He begged leave to remark that this was not a subject he had thought over now for the first time, and he would suggest to the framers of this Bill that they were proceeding on the wrong lines. He desired to point out most emphatically that they were now dealing with rights of property, with justice and injustice, and he considered, in order properly to adjudicate on these questions, the head of the Court should be a trained legal mind, that is to say, that he who was to preside over the Court should be a trained legal Judge. He thoroughly appreciated and desired very much to meet what the framers of the Bill wanted; they wanted to avoid what had been expressed by Sir Frederick Bramwell as the difficulties of instructing their counsel or the tribunal in the alphabet of the invention, but that object would certainly not be attained by creating a Court of three fixed Commissioners, who were supposed to be so omniscient or experienced that they could deal with inventions of all kinds. They had heard of an eminent engineer, and if Sir Frederick Bramwell happened to be one of the first Commissioners, he would be a man whose mind was so large that he would have no difficulty in dealing with any questions; but there was such a thing as electricity, there were such things as ordinary manufacturing inventions, such things as did not fall either within the limits of strict engineering or of chemistry, and he ventured to think that you needed a broader source of technical information to inform the Court; you wanted to enlarge the area from which you could draw your expert assistance far wider, than by limiting it to two men who might be chosen, however eminent their abilities might be. Looking at this question in a broader way, the real solution of it was this, and fortunately they had a tribunal in this country of the same class which had worked well for centuries almost, they should assist the judicial mind at the head of the Court with expert assessors in a particular branch of the scientific business they desired to inquire into. Was it a patent action which involved chemical knowledge, then have one or two expert chemists as assessors; was it one which involved mechanical details, then have mechanical engineers; was it one involving questions of mining, then have one or two mining engineers; was it one of those complicated difficulties and highly scientific questions of electricity, which were now constantly coming forward, then have one or two high expert electricians. He did not always say have two, but at any rate have one of them on the tribunal. If the inventors of this country desired to have a tribunal in which they would have the fullest confidence, they had better start by being willing to have the tribunal presided over by one of the Judges of the High Court, whose position placed them above the slightest kind of suspicion, and let that experienced judicial mind be assisted by one or two experts as the case might require. They had seen this carried out in a minor way in the

Court of Admiralty. Although there were only question of navigation, these were sometimes complicated; but the system had worked well under eminent judges for several centuries, and there was no reason why similar tribunals should not be established where persons who infringed patents should be compelled to have their questions determined. He was not in favour of special tribunals to decide the rights and wrongs of people; they ought to adapt the High Court of Justice, so that it should in its various Courts be capable of doing justice between all persons who came before it. He should be sorry to think that, in order to determine the rights of patentees or infringers, it should be necessary to depart from the High Court of Justice in preference to establishing a branch which could deal with it, or adapting the ordinary tribunal so as to make it able to deal with them. He fully appreciated the object, but suggested that the Committee had not gone the right way to work in order to obtain it. One point had certainly astonished him. One of the most difficult class of patents to be dealt with was that in which the examiners had endorsed a certificate of the alleged invention not being subject-matter, or not being a novelty, and they were not to be dealt with by this specially well constituted tribunal; that class were to be remitted to the poor twelve men in the box, who had had the privilege of dealing with all these questions for so many years. It struck him that the framers of the Bill must have had a little doubt as to the sufficiency of their tribunal, if the most difficult class of patents, namely, that which the patentee insisted was a good one, but the Commissioners thought a bad one, should be taken away from the special tribunal, and left to be dealt with by the ordinary twelve men in the box who had been supposed to solve every difficulty for the last ten centuries. Joking apart, and speaking as one interested in scientific pursuits, as well as a mere lawyer, although he was anxious to see the best tribunal possible, he did believe that, if the inventors of England would think it over, they would be satisfied that the best tribunal was one presided over by a highly trained judicial mind. There was so much good in the Bill, that he hoped, in some shape or other, it would pass, and if it did, he was sure that the inventors of England would owe a debt of gratitude to the Society and to the Committee, for the pains they had taken to improve their position.

Mr. Alfred Carpmael said that he, perhaps, might claim to address the meeting on the same ground as Mr. Webster had, if on no other. His father was a great friend of Mr. Webster's father, and spent his life upon this subject, and the little he knew of it he had learnt in the main from him. All who had taken any part in preparing it must feel very grateful to Mr. Webster for the way in which he had referred to the Bill; but he thought all who had listened to him would remember what was said in that room by a great advocate, when they heard Mr. Bramwell's paper on the subject of the Patent Laws some years ago—namely, that if there were in the room an advocate equally skilled as Mr. Bramwell, he would find arguments contrary to those which Mr. Bramwell was suggesting which might have great force. He only wished there were in the room an advocate as skilled as Mr. Webster, to whom he could communicate what he wanted to say; but, failing that, he must do the best he could himself. This question of the Courts had been thought over by inventors a great number of years; but, before going further into that question, he should like to ask Mr. Webster whether, in his experience, he always found that her Majesty's High Court would listen to this class of cases, or whether he could not recollect cases, involving very small mechanical knowledge, which had been driven away as not fit for trial by those Courts. If he could not say that, if they could not go to the sources they were accustomed to drink at, they must go to another source, and that alone would be a reason why they should get another Court; but when most of the judges allowed—he said most because there were conspicuous exceptions—that they did not think cases involving mechanical details were proper to be tried in Court, he would ask, were they not right as a rule? Did not the education of lawyers tend to make them attach too much importance to words as distinguished from things? Did they not, from the very moment they began to study, look at what had been said, and, if they could not find in the four corners of the Act of Parliament, their grant, their lease, or their will, as the case might be, actually expressed, did they not, as matters of course, put any indications of it on one side? Now, that was exactly the wrong frame of mind to bring to a specification. You want to find what the man had done, not what he had said, or what somebody else had said for him. He did not deny that, if the Courts would take these cases, that at some greater expense, which was a serious matter, justice would be done. They all admired the Courts far too much to say anything in disparagment of them, nor was it in the least disparaging to say it was an expensive process to instruct a judge, whose mind had not been familiar in patent matters, in what an invention or an abstruse subject was about. Those were his own private opinions, but others held different opinions. He held in his hand a letter published on this subject in 1848—"A proposed Bill amending the Patent-law," that was written by Robert Stirling Newall, of Newcastle, which had been sent to him in consequence of his interesting himself on the preparation of this Bill. Mr. Newall said, referring to the Courts, "the great difficulty, expense, and trouble of obtaining redress in cases of infringement, is a permanent inducement to dishonest persons to run the risk of infringing on the rights of patentees. It leads to expensive lawsuits, and loss of money before an infringer can be stopped." He proposed a strong remedy, the main feature of which was, the appointment of a standing Commission. He said they would have to pay the Commisioners handsomely, and there would be no difficulty in getting men to do the work faithfully and well, "a thousand times better, at all events, than was done at present." He would also read a passage from another letter written to him by one who had given great attention to this matter. He said, "Passing over all the details, the great change the Bill proposes is to take patent litigation out of the Law Courts, and give it to a patent Commissioner. This I entirely approve. I consider the present practice of bringing before a judge who has to be taught, in open Court, the very alphabet of the subject he has to decide, to be simply ridiculous. I think the proposed Court good." These questions, which might be supplemented by others, might be taken to show them that there was, throughout the country, a very great doubt on the subject whether they could get speedy and satisfactory justice on patent matters in the High Court of Justice. He was glad to find that, on many points, Mr. Webster agreed with the Bill, and one point more than he thought, because he said if they wanted to have a Court, do not have a fixed Court of three men, but call in scientific assessors, skilled in the particular subject before the Court. That had already occurred to the Committce, and it was provided for in the Bill, where it was provided that, on the application of either party, assessors might be called in. With reference to Mr

Webster's suggestion in relation to the destruction of provisional specifications, he said he must confess that he had not had sufficient courage to suggest the insertion in the Bill of a provision that an inventor might go to the Patent-office to search amongst the waste-paper basket there, where he might find a provisional specification, which had perhaps been dropped by the inventor, and take it up and ask for a patent in respect of it; but he said distinctly, if it could be enacted, he believed it would be an extremely good thing. The first thing Mr. Webster had mentioned was the proposed alterations in the definition of a patentable invention, and he must own he had grave doubts whether it would be wise to interfere in the matter. He entered on the question with great trepidation. They had endeavoured to keep all the advantages of the old decisions on the subject of subject-matter, and to insert some more, which it was hoped would have the effect of still further securing inventors. If they had not succeeded, and it was quite possible they had not, he should be quite ready to reconsider that part of the Bill. Mr. Webster said he cordially approved of allowing a patent only to be attacked where it was alleged to be infringed, and if that provision only could be inserted in the present Act, it would of itself be an immense boon to patentees, and would be worth all the trouble that had been expended on the Bill. It was said if they had examiners of only ordinary ability, they would get in great difficulty, and in that he entirely agreed. If it was supposed they would have examiners for £200 or £300 a year, who would do all the work, it would be a grievous disaappointment. The whole gist of the Bill was to have competent men, and that the highest men should be placed in positions of rank and respect, and of course with proper remuneration. The Commissioners should have at least the rank of a Judge of the High Court and equal emoluments; and if they could get one of the Judges from the Bench to take the post of legal Commissioner, he should consider this the best thing that could be done. There must also be a staff of very competent examiners whose pay should be satisfactory, and they should be men of scientific knowledge and attainments. He thought if Mr. Newton would look at it from that point of view, he would see that some of his objections would fall to the ground.

Mr. Lofts said he was the owner of several patents. He had read through the Bill with great pleasure, and examined it very carefully, and had also listened with great attention to the remarks of Sir Frederick Bramwell and the other gentlemen who had spoken. He had no fault to find with the Judges, having been heard once before Sir George Jessel, and twice before Mr. Justice Fry. The result certainly was splendid. It cost him over £5,000 for one patent in seven years for law, and when he started he only had threehalfpence in his pocket. He had one patent which had gone over the civilised world, and with which he had made all the money he had paid to the lawyers, leaving something for himself besides; but still he thought they had had too big a share of it. Three Commissioners never could do the work. As Mr. Newton had said, it would require four days to go through a specification. It took him and Professor Stuart, of Cambridge, nearly a week to go through a certain specification, because he volunteered to come as a witness in some case, and he was not an ordinary man. He thought a patentee ought to be allowed to improve and alter after the final specification. He had now just completed, after twelve months hard work, one very valuable invention, but if he were not allowed to protect it and have plenty of time for the complete specification afterwards, it would be useless. The Commissioners, or any of the persons in connection with the Patent-office, ought not to hold any other office; but he feared it would require 100 Commissioners to examine patents in the form laid down in the Bill. It was proper they should be examined, but he did not think 100 men could do it effectually, because it would be found there would not be 5,000 but 9,000 patents a year. He believed about 2,500 of the present patents taken out were worthless, 12 had been surrendered to him that had been taken after his; three had been cancelled before the Court, and others had been surrendered on the advice of counsel. One provision of the Bill seemed rather peculiar, that if a patentee should bring an action he should be bound to find security in the sum of £100 to compensate the defendant. Why not bind the defendant also in the same sum? In an action he had taken he went to a man who had infringed his patent, who said he did not care, he had not got £10 to lose; although he had got an interim injunction, the defendant refused to sign a perpetual injunction, unless he gave him £50, so that he was really called upon to pay the money because he wanted to get rid of him. He said, not untruly, "it will cost you £500 to pay the lawyers, you had better pay me £50." With regard to sending notices by letter, he thought they ought to be registered, so as to have proof of delivery. It was stated that the provisions of the Bill should not extend to any existing patent. He quite understood the reason of that, because there were so many worthless patents, but if a patent had been established in Court he thought the owner ought to be entitled to the benefit of the Bill. With regard to granting a patent of £10, he should say make the payment at the expiration of the fourth year £40, but let the patent be taken out for £2 10s. When he first started he was obliged to pledge his furniture, his watch, and his clothes to get the £25 to take out the patent. It would have been much easier if he had only £2 10s. to pay, and he could have paid £400 in six months, for he took one order in London of £800, out of which he made £400, and the purchaser saved £6,000 by it in six years.

Sir Frederick Bramwell said it was evident the discussion would have to be adjourned, but as the Chairman would not be able to be present on a future occasion, he was sure the meeting would desire to hear him before closing.

The Chairman said he had not had time to examine this Bill will all the minuteness which it deserved, but he had read it through, and several observations upon its provisions had occurred to him, which he would proceed to state. In the first place he cordially agreed with what had been said generally in the praise of the Bill, and he thought the public at large, and especially those who were interested in inventions—which they all were—owed a great debt to those who had taken so much pains and trouble, and who had produced very much which was truly admirable. Upon that subject everyone who had spoken had been unanimous, and the observation of Mr. Webster in particular, with whom he substantially agreed, ought to carry great weight, both on account of his exceptional experience, and on account of the fact that he did not altogether approve of the provisions of the Bill. He should not enter at any length on the provisions of the first part of the Bill, because upon that he felt that persons whose practical experience had been much greater than his own were entitled to far more attention than he could be, but he would make this general remark on those provisions: he was sure those whose business it was to consider the Bill in detail, would bear in mind a difficulty which was almost inherent in the nature of the Bill, and that they would, as far as possible, provide for it. It was a difficulty pointed out by Mr. Newton, and which the last speaker had also referred to in a striking manner. Mr. Newton said, if the examination of specifications which was proposed to be made by this Bill were carried out as it ought to be, the result would be that no Commission of any moderate size would be able to get through the work, and that was strikingly confirmed by the last speaker, who said that his specification took Professor Stuart, of Cambridge, fully a week to understand, and there must be many others of a like kind.

Mr. LOFTS said it took him that time to compare it with others which bore on the case.

The CHAIRMAN said the details did not much matter; the effect of it was that it was a very laborious thing, even for a highly-skilled person, to examine the details of the specification; consequently if the Bill was to be thoroughly worked, it seemed very doubtful if it could be done with the staff of persons proposed to be employed. What did that prove? It seemed to him to illustrate the real difficulty in this matter of specifications and examinations which lay at the root of the whole subject. They must take practically one of two lines; either they must allow a man to take out a patent at his peril, and run the risk of its being infringed, and have the infringement determined by an action at law, which, speaking broadly, was very much what was done now; or every patent must pass through a preliminary examination in order to see whether it was a good patent. That seemed to him to come to this; they must either have a lawsuit—call it by what name they liked—in every case whatever, or else they must leave people to take out their own patents at their own peril, and at the risk of law suits. The difficulty of determining, before granting a patent, whether it was good or not, practically amounted to a kind of lawsuit in every case, although it did not take the form of litigation between party and party, but took the form of getting the matter into the head of an examiner, which Mr. Newton considered a difficult operation, a tedious and more or less expensive operation—or if you did not do that, you had to allow a patent to be taken out as it was now, and run the chance of litigation. The question was, whether you liked to have the lawsuit and pay for it at all events; or run the risk of having one afterwards, and he did not see how that dilemma was to be avoided. This Bill appeared to go on the principle that it was best in every case to have the preliminary examination, which must be more or less expensive and laborious. He did not say it was not right, but it was a matter to be weighed fairly, and thoroughly understood beforehand. Passing from that, he came to the part of the Bill with which he did not agree, that was the part of it which proposed to take these actions away from the High Court, and to transfer the jurisdiction of the High Court of Justice in England to three Commissioners. On a great variety of grounds he was altogether unable to agree to that proposal. There was one small matter, which might be dealt with and put out of the way. One provision in the Bill appeared to him, quite unintentionally, to be a direct vote of censure on the High Court of Justice, and that was the section which confined the operation of this Bill to England. In Scotland, and in Ireland, in the Channel Islands, and in the Isle of Man, the High Courts of Justice, or whatever courts of justice there were, would try these cases. He did not think there was a High Court in the Isle of Man, but they had an excellent person, whom he knew very well, as Chancellor and Chief Judge of the island, and he was to be allowed to go on trying these actions; and so would the Bailiffs and Jurats of the Royal Courts of Jersey and Guernsey, and so would the High Court in Ireland, and the Courts of Session in Scotland. Why the High Court of Justice in England should be snubbed in comparison with the Courts he had mentioned he did not know. If the High Court in England was to be deprived of jurisdiction over patents on the ground that it was matter they could not be expected to understand, the same measure ought to be applied to the Scotch, Irish, Isle of Man, and Channel Islands Courts. He did not see why, if the Commissioners were to go into all parts of England, as they proposed, to carry cheap justice to the inventor's door, why they should not go to Ireland and Scotland? This was a small matter, but there were two main objections he wished to put before them; one from the point of view of the inventor, and the other from the point of view of the administration of justice. First, from the point of view of the inventor. He had had the privilege of presiding in that place seven years ago, when Sir Frederick Bramwell delivered one of the most interesting and beautiful lectures which he ever had the pleasure to listen to, on the law of patents; and he believed the delivery of the lecture produced on the public mind a very great and wholesome effect, teaching people to understand that the existence of rights of patentees was for the public benefit, and the only practical means by which inventions could be introduced and properly worked. He was delighted to hear him, and agreed with nearly every word he said, and had not seen any reason to alter his opinion since; but at the same time he would remind them that there was a side to the question which had not been touched upon that night, and which it was not his intention to enter upon. He thought, and probably they all thought, that the rights of patentees were of high importance and ought to be maintained; but there were those who looked upon them as being a shackle on their proceedings, and as an infringement of the common rule against monopolies, which, no doubt, they were, although from wise and good reasons. Now, did they suppose, when there was already some jealousy on the subject of patents, and when the public had been at one time, within a few years, disposed to question their utility in general, that the public would receive with favour a plan which not only confirmed the patent rights, but which constituted a separate Court for the purpose of protecting them, which Court was to be composed of persons who were themselves, and naturally by their profession and habits of life biassed—he did not say in favour of any individual—but biassed in favour of the inventor's view of the subject? The Bill proposed to have a special Court to enforce rights, not altogether so popular as he thought they ought to be. He did not think that was a wise plan. It had been tried with regard to a variety of matters, and had not been found satisfactory. One word upon the manner in which the Court was proposed to be constituted. There was to be a person experienced in engineering, and a person experienced in chemistry, and a person experienced in law—he should have thought they might have said a barrister of so many years standing, but perhaps that was not worth saying much about. But even three persons of experience, or two, putting aside the lawyer, he should have thought hardly divided between them the whole domain of human knowledge. For instance, Mr. Webster had mentioned the case of electricity; he might mention the case of optics; he might mention the case of inventions connected with surgical instruments. These were illustrations which occurred at once, and there might be many others. He could not think that those two persons would divide between them the whole domain of invention and manufacture. The authors of the Bill were sensible of that fact, because in the two sections already referred to, provision was made for their having the assistance of experts. They were to have experts to assist experts. There was to be a lawyer, but he was not to do much, because he was never to sit in the first instance. One Commissioner sat in the first instance by himself, and he was to have a lawyer, not the legal Commissioner, but a legal assessor. Then there was to be an appeal from this one Commissioner to himself and another Commissioner and the legal member of the Commission. He could not see that that could be a satisfactory Court. Let him remark in general terms (and he spoke in the presence of those with whom it would be unnecessary to go into detail), that there was hardly any branch of the law which contained such refined and such interesting principles as the law of patents; and he referred to Mr. Newton's and Mr. Webster's observations upon the definition of what you mean by a new invention. What did they say? Let us keep what we have got, because we know its meaning. But how do they know its meaning? By repeated judicial decisions. Was that law complete? He should think it was not—very far from it. And did they think it was capable of being completed by the decisions of a Court composed of two gentlemen whose lives had been passed in very different pursuits from those of investigating legal principles? If anyone really was of opinion that the highest chemical knowledge or the greatest engineering skill would enable a man to understand the legal principles which underlie these complicated questions, he was much mistaken; and he could hardly know much about the law of the land. He knew himself, by the study and experience of many years, that there was no more laborious and difficult matter than to understand and investigate the general principles connected with law, and those connected with the law of patents were as difficult to represent clearly to your own mind as anything could possibly be. If they were going to try to take from lawyers so delicate a function as that, and to intrust it to a chemist and engineer, he did not think the result would be satisfactory. Before passing from that point, he would say one word on what Sir Frederick Bramwell said about the Railway Commissioners, which he considered formed the precedent for this new Court. He thought Sir Frederick hardly realised the difference between the duties of the Railway Commissioners and the duties of a Court of Justice. The duties of the Railway Commissioners were to say on what sort of terms the railways ought to deal with the public; what sort of accommodation to the public they ought to afford; and in fact how it was desirable in the public interest that railway directors should exercise the power conferred upon them by Parliament. That was the duty of the Railway Commissioners, speaking very generally, and it was a duty that had nothing legal about it. It was a duty to lay down rules which might be expedient for the conduct of business in which the public were interested, and was altogether foreign to law. He might add, however, that the Railway Commissioners found considerable difficulty in discharging their duties without having recourse to the Courts of Law. Such recourse had been frequently had upon the question of what the precise duties of the Railway Commissioners were, and the view of the Court had not always coincided with the view of the Commissioners. What was the reason why this great change was to be made? On three grounds: first, that the present law was too expensive; secondly, that the Judges were not scientific; and thirdly, that they would not hear cases. With regard to the expense of an action of this kind, it depended mainly on the agent's bill, the solicitor's bill, and the counsel's fees. Now he thought Mr. Webster showed considerable knowledge of his profession when he said he did not think it would hurt his interests if the Commissioners were established instead of the Courts of Justice. Depend upon it, the inventor would have to pay the agent for the specification, pay the same counsel, and pay the same fees; and if he had the satisfaction of having the Commissioners come down from London to some remote part of England or Wales, to bring justice to his own door, he would have the satisfaction of bringing counsel with them, who could not be expected to come for nothing. In short, he could not see how a trial before one tribunal could be cheaper than a trial before another, except with regard to the matter which Sir Frederick Bramwell referred to, when he said you had to make a quantity of spelling books and object lessons for the sake of the ignorant people who presided on the Bench, and the still more ignorant people who sat in the box. Now as to the want of science on the part of the judges; he felt some delicacy in dealing with the subject, but he could speak from experience. Sir Frederick Bramwell had said some kind things of him about what had happened a long time ago, and he feared his kindness had rather exaggerated the matter, but he thought that a man who had Sir Frederick Bramwell on the one hand, and Professor Abel on the other, to explain the matter in dispute, and could not understand what they told him, could hardly possess the qualities necessary to raise him to the judicial bench. For his own part, any knowledge he might have about machines was to a considerable degree due to Sir Frederick Bramwell's instructions, and where you could procure the assistance of persons of great breadth of knowledge and genius for illustration, it was almost impossible for anyone—even a lawyer—not to understand what he was stating. He might observe, with regard to judicial qualities and training, that in his opinion the great art which lawyers had to acquire, and which was almost indispensable to any man who succeeded at all in the higher walks of the law, was precisely the art of acquiring information from others; and although you might think it was a light thing, and say it was merely the power of being crammed, yet the power of receiving information upon a new subject, of arranging it in your mind clearly, and then viewing it in reference to legal principles, was a power which nearly every lawyer of any degree of eminence was obliged to acquire, which he did acquire, and which went far to constitute what Mr. Newton referred to, when he spoke of the importance of a legal mind. He had the strongest possible conviction that if you had not that power you would never be able to give satisfactory decisions, even if you were the best chemist or engineer in the country. One word upon the objection that judges would not hear patent cases. There might be cases in which a judge did take up to some extent the part of Gallio, and say, "if this were a matter of goods sold and delivered, oh ye inventors, reason were that we should hear you; but if it is a matter of cams and levers, and the pressure of steam, we will be no judge of such matters;" and then to use an expression he once heard from an eminent person, "he drives them from the judgment seat." That might have happened on some occasions, and if it had happened it was to be regretted; but there might be found an easy and complete remedy for that without the establishment of this new Court. The existing law and procedure gave the power of having a hearing before a judge and assessors. The procedure was now under process of revision, and let it be put into the new provisions about procedure, that in cases of this kind, the ordinary mode of hearing should be before a judge or assessors. There they would have the very Court which they wished for, or rather a better Court, because they would have a legal mind to preside and be responsible for the decision, with two professional experts to give him the advantage of their learning, and make him understand what was the matter in issue. A slight further modification would complete the whole thing. Let it be laid down that all cases to be tried before a judge and assessors should be put into a special list by themselves; then when the judges met from time to time, as they do at the beginning of every sitting, to assign his particular work to each judge, a particular judge would choose a list of cases to be tried with assessors, and they might be very sure that the list would hardly be chosen by judges who felt themselves incompetent to try that particular class of cases. There was no occasion for a separate Court: you had merely to make the slightest possible alteration in the existing procedure of the High Court of Justice, and you would have as separate a tribunal as it was desirable in the public interest to have. But he would go rather further on this matter, for it was really a matter of great interest and importance, especially to everyone who held the position which he held; for he must say frankly, and he made no secret of it, he did feel that the High Court of Justice would receive a decided rebuke if the Legislature were to lay down that there was any class of cases usually coming before that tribunal which it was not competent to decide. He hoped, although he was a lawyer and a judge, and some of them were not favourable to lawyers, they would not fail to appreciate his feeling, which he believed would be common to every person in his position, that he did not like to have it said that he could not do the work he undertook to do. Now, he would point out a few difficulties involved in this Bill. As he had already said, the Bill applied only to England, but he would pass that by. It applied only to actions for the infringement of patents. It was objected that the High Court was not competent to try actions for infringement of a patent, and took away those cases, of which there were about nine in one year. But what did it leave? It left ten times as many cases involving precisely the same kind of subject as those which were taken away. He might mention a certain number which had come under his own observation. He would ask whether a tribunal having to dispose of them could be unfit to dispose of an action for the infringement of a patent? There was one case memorable in his mind for many things, but especially memorable because it first procured him the friendship and acquaintance of Sir Frederick Bramwell. In that case—perhaps not to the satisfaction of the litigants, but infinitely to the satisfaction of the counsel—they were employed two years or more, and had to examine and to go through a number of machines of the most beautiful kind, which they examined with such minuteness, that he thought at that moment, if it were necessary, he could give a full, true, and particular account of the way in which screws are made. They had to consider the comparative value and merits of six different machines—two sets of three each, and the comparative value of each for the purpose for which it was devised. That action was not a patent action at all; it was an action as to the sale of the goodwill of a business; but in order to ascertain that, they had to ascertain how certain patent machinery worked, and how particular machines were related to each other. Was the High Court to be allowed to deal with actions of that kind? Take another case; an action of wrongful dismissal of a servant, and for not paying him certain sums of money as per agreement. Answer—"I employed you on the terms that you were to introduce a certain patented machine into my manufactory, and you were to perfect it, and to do this and that with it." That action again involved the whole question of these machines, and of the patents on which they were constructed, and their relations amongst each other. That was tried in the ordinary way, and as under this Bill it would still be tried. He might go on with many illustrations of the kind, but would only mention one more, because it illustrated another point. In many cases, matters relating to patents strictly, turned entirely on questions of law, and the matters with regard to patents and patentable matters, come in only incidentally. One case of the kind (in which Mr. Webster was engaged), had caused a great deal of attention. It was not in terms an action for the infringement of a patent, but it was identically the same in principle. It was the action of the Post-office authorities against the Telephone Company for violating the monopoly conferred on the Post-office by Act of Parliament. In order to determine that action, it was necessary for the Court to say whether the telephone was a telegraph within the Act of Parliament or not, and for that purpose it was necessary to go into the whole question of the nature of telephones and telegraphs, and their relation to each other. The judgment of the Court on the subject could not have been very wrong, because it was never appealed against, although it might have been. He might say, with regard to that, that he felt perfectly confident that if they had left the question between the telephone and the telegraph to a Court composed of an engineer and a chemist, or any scientific men you liked, and taken it away from lawyers, they would never have understood the question. He was sure they would not, because the question turned entirely on the construction of an Act of Parliament, and although there was a great deal of scientific evidence, it was beside the point. It did not go to the point of the case, which was—what did these words mean in this Act? They had a number of affidavits by the most eminent scientific men in England, who were ready to swear to any extent that a telephone was not a telegraph, whereas the whole question was, not what a telephone or telegraph was, but what the Act of Parliament had said. That illustrated the point which he had put already, namely, that legal questions could not be decided satisfactorily by men whose pursuits had been in other departments of life. He could point out plenty of illustrations of the curious way in which it would operate; for instance, in the revocation of a patent. A patent was liable to be revoked if obtained by fraud. Was that a question of chemistry or engineering? He should say, if there was a question which was a question of law and of fact, or a question of law arising out of fact, it was the question of fraud. Why was that to be taken from the ordinary Courts of Justice, and put into the hands of an engineer and chemist, with a supplemental lawyer? He had had time to read the Bill only superficially, but there were a great many things which he could say about it, and there was this one of great importance. The whole run of legislation of late years had been to simplify and consolidate litigation as much as possible, so that if two persons were at variance, they should be able at one proceeding and at one time to get the whole of the matters between them settled, and everybody would admit that that was a proper plan. It was in order to carry out that, that what they had been accustomed to call the fusion of law and equity was considered a very great step in advance, and he supposed no one would wish to go back from it. One part of the doctrine was this, that if you brought an action against a man to recover money, he might reply, not only that he was not indebted for this reason or that, but he might counter-claim against you for anything, as for instance, in an action for goods sold and delivered the counter-claim might be for breach of warranty, anything—for assault, or for any thing you pleased. That was a point which was not dealt with in this Bill. A counter-claim for the infringement of a patent would be a good answer to an action on a contract. The plaintiff might say—you have wrongfully dismissed me from your service, and the answer might be, "Yes, I have, but you have infringed my patent and you must pay damages for it." The High Court of Justice, under this Bill, would be able to try that action, although it could not try an action for the infringement of a patent. He did not think that could have been considered when the Bill was drawn, for if it had been, it would have brought to light at once an incurable defect in the Bill, namely, that it must either forbid counter-claims in actions for the infringement of patents, or empower the Commissioners to try counter-claims, which would enable them to deal with all sorts of actions, having nothing to do with science. That matter seemed to him highly important. By taking away one class of cases from the High Court, you destroyed the very thing which had been so elaborately constructed a few years ago, namely, an arrangement by which a man might get the whole of his disputes settled at the same time, and by one and the same proceeding, and surely that could not be desirable. They had been told by Sir Frederick Bramwell something which explained a provision of the Bill which had filled him with astonishment. The Bill, he had no doubt, was carefully and well drawn, and it was drawn on the recommendations of a body of experts, of whom he would only say, that if they got better ones to be Commissioners, they would be unusually fortuuate. Let him call attention to a statement of the law which appeared on the Bill—to go no further. The Bill said that a person who was sued should be held to have infringed a patent if he failed to establish any of the pleas allowed by the Act, and then followed a list of pleas which were allowed, and they were eight in number, and no more. Therefore you must not plead anything else except those eight pleas. In the first draft, they had left out "leave and license," which seemed rather a strange thing. They would not have been able to plead that, if it had not been put in at the last moment. That showed they must be careful with these things, because it certainly would have been a strange matter if a man had been prepared to prove leave and license, and the Act of Parliament had said he should not. Still, the pleas they had forgotten to put in now were not unimportant; for instance, although you might plead leave and license, you must not plead "accord and satisfaction." If you infringed a man's patent, and the patentee came and said you had been infringing my patent, and you say, "Well, yes, I have; I am sorry for it, and will give you £20 for it," and he took the £20, one would suppose that that would be an end of it; and if you got a notice that you were to be sued before the Commissioners, you would say, "Here is your stamped receipt of £20, in satisfaction of your claim," but the answer would be, "That is a plea of accord and satisfaction, and that it is not one of those eight pleas—you must not plead that—pay up." He thought that was a hardship; at least that was what occurred to the legal mind. The legal mind is occupied, as Mr. Carpmael, with his experience, said, solely with words and technicalities, and thought nothing of things, and what a man had done; but it seemed to him, that when a man had paid £20 in satisfaction of an action, he had done something very considerable. Here was another thing. You brought an action against a man, and said, "You have infringed my patent;" and he says, "When did I infringe your patent?" "Well," you say, "I am the executor of the executor of the executor of the assignee of a man who took out a patent in the year 1750, and you are the executor of some other people who infringed that patent." One would say, "Good heavens! that is 130 years ago, you do not mean to say you are going to sue me for that?" but the answer would be—"Oh, but you cannot plead the Statute of Limitations now, you are to plead no plea at all, except the pleas which are in this Bill, and the Statute of Limitations is not one of them." What should they think of that? Did they not think that the legal mind was not absolutely without its use? There was a great many more things he could mention. For instance, section 7 laid down a great many rules, which might be very proper, about cases where inventions were patented abroad—you were not to take an invention patented abroad away from the patentee. If, however, a man did take out such a patent wrongfully, you could not under this Bill rely upon that as a defence to an action for infringement, for it is not one of the eight pleas mentioned. There were many more cases of the same kind. You could not plead, for instance, that the patent was obtained by fraud; you must go back and have a proceeding to repeal the patent obtained by fraud before you could avail yourselves of it. He could see the object which they had in view, which Sir Frederick Bramwell had explained, and an excellent one it was. The object was this, suppose a man pleaded, "you say I have infringed head A of your patent, and it is very true; but head B of your patent is void, and therefore I am at liberty to infringe head A." It might be that that particular plea ought to be taken away, but how was it taken away? By enumerating first six pleas that occurred to them, and then eight, and saying, you must not plead anything else. It seemed to him it would have been a much simpler way to say you shall not plead this, than to say you may plead all these eight pleas, and no others. He had shown what the effect of it was; it shut out important matters which ought to be pleaded. There were several minor matters which had occurred to him in reading the Bill, but he would not refer to them for two reasons. In the first place, he had spoken long enough; and in the second place, they were matters which could not be well discussed in a large assembly, and would give the impression, which he was very far indeed from wanting to give, that the Bill had not been drawn with proper care. He had had some experience in drawing Bills, and knew how laborious a business it was, and how many niceties there were in it, and therefore he thought the way in which he could make what he had to say upon these minor points most useful, would be by writing a note upon them and communicating with the committee, who he hoped would take this excellent Bill in hand, and make it as good and as useful as it ought to be made; but he could not help saying what he had, as he had been asked to give his opinion upon it. He did not like the latter part of the Bill, but he did like the early part of it, and certainly hoped it might pass into law in due time, with proper consideration. Whenever it did, like it or like it not, he should at any rate feel very glad that Sir Frederick Bramwell and his assistants should have done so good a piece of work.

Sir FREDERICK BRAMWELL then proposed a vote of thanks to Sir James Stephen, which was carried unanimously, and the discussion was adjourned until Thursday, December 15th.

FOURTH ORDINARY MEETING.

Wednesday, 7th of December, 1881; C. W. Siemens, D.C.L., LL.D., F.R.S., Vice-President, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Allfrey, Edward Richard, South Eden-park, Beckenham, Kent.
Austin, Josiah, Nechells-house, Nechells, Birmingham.
Ayrton, William, Wigan-road, Ormskirk.
Clerk, John Somervail, 39, Prince's-square, W.
Colvin, Clement S., India-office, S.W.
Glover, Walter T., Moorhurst, Kersal, Manchester.
Hallett, Holt Samuel, 37, Edgware-road, W.
Hawksley, Thomas, 97, Adelaide-road, N.W.
Hill, James Woodward, A.M.I.C.E. (Mayor of Bedford), Kimbolton-road, Bedford.
Knox, B. D., Caversham, Reading, Berks.
Peck, Robert, Lowlands, Half-moon-lane, Herne-hill, S.E.
Stuart, Robert Henry Frederick, A.M.I.C.E., Holmwood, Kew, Surrey.
Turnbull, George, M.I.C.E., Rosehill, Abbots Langley, Herts.

The following were elected as Members of the Society:—

Barlow, William Henry, F.R.S., M.I.C.E., 2, Old Palace-yard, S.W.
Bryden, Frank J., 2, Bulstrode-street, Welbeck-street, W.
Ekman, Carl D., 57½, Old Broad-street, E.C.
Gregory, Bertrand, F.C.S., Claremont-park, Blackpool.
Habershon, Samuel Osborne, M.D., 70, Brook-street, Grosvenor-square, W.
Hardingham, George Gatton Melhuish, A.M.I.C.E., Oriel Lawn, East Moulsey, and 191, Fleet-street, E.C.
Lowood, John Grayson, The Brooms, Glossop-road, Sheffield.
Miley, John, 14, Hilgrave-road, South Hampstead, N.W.
Montgomrey, Archibald, Bush-house, Isleworth.
Owen, Charles Thompson, 19, Compton-street, Chesterfield.
Paterson, Edward J., 76, Little Britain, E.C.
Pearson, Henry William, A.M.I.C.E., 17, Alexandra-road, Clifton, Bristol.
Thornhill, Lieut.-General Anthony Robert, Lavender Farm, Bracknell, Berks.
Tinney, W. Upton, A.M.I.C.E., Staple Garden Winchester.
Turnbull, George, 2, Collingham-place, South Kensington, S.W.
Ure, The Hon. John (Lord Provost of Glasgow), Cairndhu, Helensburgh.
Wills, W. M., 57, King William-street, E.C.

The Paper read was—

THE COMBINATION SYSTEM OF STEAM HEATING FOR TOWNS AND VILLAGES.

By Capt. Douglas Galton, C.B., Hon. D.C.L., F.R.S., &c., &c.

The vast increase in the size of the metropolis and of other towns in the United Kingdom, has brought into prominence the question of how to maintain a pure atmosphere over such extensive congregations of houses. One of the most prominent causes of impurity in a town air is smoke and soot.

Where vapour of water or fog prevails, it has been shewn that when particles of coal-tar are floating in the atmosphere, they attach themselves to the watery vesicles of fog or cloud, and coat them with an oily film, which retards the evaporation of the water. These conditions operate to give a greater degree of permanence to a cloud thus composed of watery vesicles and smoke, than clouds consisting of watery vapour alone possess.

The Exhibition which has been opened at South Kensington exemplifies very clearly that this cause of impurity is, to a large extent, under our own control, and that, with more careful and scientific appliances, we might easily reduce the quantity of visible impurity which our chimneys vomit into the atmosphere.

The various apparatus which are exhibited may be divided into those, on the one hand, which deal with the method of consuming coal in a smokeless manner, in each separate house; and, on the other hand, those which make use of gas, and thus require some central establishment to create their smokeless fuel, and transmit it to the several houses, to be there applied to heating and cooking purposes.

The Exhibition does not, however, contain any description of a method of heating which was proposed a few years ago, and has actually been adopted in the United States of America. This provides for consuming the fuel at a central source of supply, and sending thence the heat itself to supply the several houses in connection with it, and the system thus dispenses with the necessity for consuming the fuel in each individual house. This system is called the Combination System of Steam-heating for Cities and Villages, and was devised by Mr. Holly.

The system of heating houses by steam, instead of by hot water, has obtained a large development in the United States.

In the ordinary steam-heating apparatus which is in general use in houses in the United States, and in which the steam is under pressure, the flow pipe should be carried in as direct a line as possible from the boiler to the highest point; all the coils for heating should be placed on the return pipe, which should be laid in a uniformly descending line back to the boiler, so arranged as to prevent the lodgment of any condensed water on its way there, it being a source of economy in steam heating that the condensed water should flow back to the boiler.

The use of steam for heating pipes for warming purposes possesses certain advantages, and when the object is to warm air, the higher the temperature of the pipes the greater is the comparative effect. When compared with pipes heated by hot water under ordinary conditions, steam-heated pipes also possess the advantage that when a high temperature is obtained in the pipes heated by steam, there results the consequent radiation of a larger proportion of heat to the walls of a room.

Steam heating possesses some disadvantages. The steam frequently makes unpleasant noises, if air or water lodges in the pipes. The heat given out is very great, and becomes often oppressive. Under the ordinary arrangements for steam heating, the temperature of the pipes cannot be regulated as with hot water. This latter objection is met to some extent by separating the coils into parts, which can be put in operation consecutively.

Mr. Holly, in the system of combined steam heating which is about to be described, has devised an arrangement of pipes, which he terms the atmospheric radiator, to enable the temperature of the pipes to be regulated. In the combination system of steam heating, the steam, when once it enters the house, becomes the property of the occupier of the house, and the condensed water does not return to the boiler; the steam for the radiators is taken out of the flow-pipe through a valve, regulated by a thermostat, so arranged as to open and close the valves, admitting steam to the radiators; this thermostat may be adjusted to operate to within ten degrees of temperature, so that the heat of a room may be automatically maintained at about the temperature desired. The steam is admitted at the top of the radiator, through the valves, in such quantity as is desired, the bottom being open; the amount of steam admitted is determined by the temperature which it is desired to maintain, and by the amount of radiating surface. Thus, if a moderate temperature is required, a little steam will be admitted to the upper portion of the tubes. The heat from this small quantity of steam will be rapidly diffused by the surface of the radiator through the air of the room, and the inlet valve can be so adjusted as to control the amount of steam admitted; by this means the temperature of the room may be maintained at any required degree. The advantages claimed for these radiators are economy of manufacture, and ease of graduating to all weather; they may be made of tin, or galvanised iron, of any required height and design. The steam and water of condensation give off all their heat, and there being no valve in the return-pipe, and no pressure, there is no cracking and spluttering noise, as in pressure radiators.

The steam, after it has passed into these radiators, cools down and becomes water, and passes entirely away from the steam pipes, to be applied to such other purposes as the house-owner desires, as will presently be explained.

Thus, in the ordinary system of heating by steam, in use in houses in the United States, the steam circulates continually from the boiler to the radiator, and returns as condensed water to the boiler; whereas, in the Combination system the steam does not circulate back to the boiler, but, after it has passed into the house, passes away as water. That is to say, the steam in this system is taken from a steam main, laid through the streets, just as gas or water is taken from a main, and the heat from the steam is consumed in the houses in such a manner as owner of the house thinks fit.

The following is the general arrangement of the system:—The boilers are placed in a convenient central situation. The results given by Mr. Holly of a series of experiments on several boilers in use by him, show that, at Lockport, he evaporated, on an average, from 6 lbs. to 9·5 lbs. of water per pound of coal; this, of course, is a matter greatly depending on the quality of the fuel. Mr. Holly speaks in high terms of the Murphy smokeless furnaces, with regard to which he says:—"The perfect combustion and consequent total abolition of smoke from bituminous coal, and relative economy in the production of steam, are not the only points of superiority, as its cleanliness, ease of management, and saving of labour, are almost equally important. The stoking of the boiler resolves itself merely into dumping the coal from cars into the bin above the fire-box in front of the boiler, and occasionally pulling it towards the feed. A little engine carries it into the coking chamber, dumps it at the proper time on the grate-bars, and, by means of levers moving the shake-bars to and fro, slowly clears the bars of ashes. The doors are never opened, and one attendant, without a fireman's skill, will manage a battery of six boilers worked by the same power." This arrangement of furnace appears to have some resemblance to the McDougall furnace in the Smoke Abatement Exhibition.

From the boiler, the steam passes into the main pipes and lateral or branch pipes. These have been made of lap-welded wrought iron steam pipes. They vary in size, according to the duty they have to perform. The largest yet laid is stated to be 12 inches diameter. The maximum steam pressure would be 100 pounds per square inch; but the pipes are made to resist strains many times in excess of the maximum pressure to which they can be subjected, and they are carefully tested.

It is essential to guard against the condensation, for, unless steam can be transmitted to considerable distances without too great loss by condensation, all devices to use it in buildings, however ingenious, would of course be useless. Condensation being caused by the radiation of heat from the pipes, the object is to arrest the radiation, that is, to keep in the heat by inclosing the pipes in the best non-conducting material that is attainable and cheap enough. In order to effect this, the pipe is wound about, first, with asbestos, followed by hair felting, porous paper, manilla paper, finally thin strips of wood laid on lengthwise, and the whole fastened together by a copper wire wound spirally over all. This is thrust into a wooden log, bored to leave an intervening air-chamber between the pipe and the wood, and of sufficient size to leave from three to five inches of wood covering. The elasticity of the wrappings permits the free expansion and contraction of the pipe, irrespective of the wood log, which is securely anchored and made immovable. The whole is placed in a trench a short distance below the surface, without regard to frost. At the bottom of the trench is laid an earthen tile drain, to carry off any earth moisture; and in order further to insure the continuous dryness of the the wood log enclosing the pipe, if desired, 1½-inch plank is fastened around the log, leaving an air space, and the whole is daubed with coal tar, and covered with earth.

Pipes prepared in the manner described have been tested, and it is stated that these tests show that condensation can be reduced to a point that renders the general transmission of steam not only practicable, but profitable; that is to say, that the loss of heat by condensation is under 2¼ per cent. The only actual experiment of which particulars are given, does not furnish so high a result; this experiment was on 1,600 feet of three-inch pipe, laid on a descending grade of about 1 in 250, the lower end trapped for water, the steam pressure constantly maintained at 20 pounds at both ends, during 12 hours; and the water of condensation, carefully weighed, amounting to 82 pounds per hour; *i.e.*, about ·068 pounds of water per square foot of surface of pipe; that is, 66 units of heat per square foot per hour, or 52 units per foot run. The loss of heat from uncovered steam pipes, with steam of 40 lbs. to 60 lbs. pressure, may be assumed, probably, at something between 320 and 380 units of heat per square foot of surface, partly dependent upon the outside temperature. The Holly boilers in this experiment are stated to have evaporated nine pounds of water per pound of coal. Therefore the extra coal required to keep up the loss from condensation amounted to nine pounds of coal, or at the rate of 30 pounds of coal per hour per mile of three-inch pipe. The actual amount of condensation in large pipes is greater than in small pipes, but the relative per-centage per square foot of surface less than in small pipes. It is stated that from experiments and practice, verified in fifteen cities, the most economical pressure to be maintained in the mains, is from 40 to 60 pounds, although in some cities 70 pounds have been used. Experience with large mains is yet limited. The experience of Detroit demonstrates the fact that 60 pounds pressure could be maintained in four miles of 10-inch and 6-inch pipe, against the drafts for power and heat along the line.

In order to counteract the difficulty arising from the expansion and contraction of the pipes, which are subject to extremes of temperature, varying from, say 39° Fahrenheit, and the temperature of steam at, say 60 lbs. pressure, *i.e.*, 307° Fahrenheit, a junction and service box are used. These are placed at convenient intervals along the line, of 100 to 200 feet. The arriving-pipe from the boilers is inserted in the service-box, by means of a nickle-plated extension, or telescopic joint, made steam-tight by passing through a stuffing-box. The departing-pipe is immovably attached to the box, so that one end of each 100 feet of pipe is fast, and the other movable—affording free play to the expansion and contraction.

All service-pipes are taken from the junction-box, which is securely bolted to the masonry and anchored to the pipes. The bottom of the box being placed lower than the pipes, all water of condensation is carried forward, and deposited in it; the arrangements for the escape of the condensed water from the steam-pipes will be described presently.

At each point of consumption there is a cut-off, under the control of the consumers. The supply-pipes from the mains to the houses are 1½ inches in diameter, and within each house ¾-inch pipes are used. In addition to the cut-off tap from the main, under the control of the consumer, there is a pressure valve or regulator, by means of which the pressure of steam is reduced, and the supply to the building regulated automatically. This is accomplished by two diaphragms of rubber packing, acted upon by weighted levers, and moving two slide-valves. The first valve is weighted to 10 lbs., and the second to 5 lbs., or 2 lbs. if required.

When the steam arrives at the first valve of the regulator, it is under a pressure of 60 lbs.; on passing through the first reducing valve, the pressure is reduced to 10 lbs.; it is then passed through a second reducing valve, and the pressure lowered to 5 or 3 lbs.; thence it passes at this uniform pressure through a meter placed above the regulator, for measuring the amount of steam which passes into each house. Unfortunately, I am not in possession of a drawing or description of these regulating valves or of this meter sufficient clear to enable me to explain their action in detail.

The distribution of heat in the apartments is by means of the radiators before mentioned, which are of the ordinary shape, consisting of inch-pipes about 32 inches long, placed vertically, either in a circle or in a double row, and connected together top and bottom. The action of these, in enabling the heat to be regulated, has already been explained. The steam, in passing these radiators, becomes condensed into water at 212°. The heat then remaining and the water may both be utilised. In order to effect this, it is conducted in protected pipes, from all parts of the building where steam has been used, back into the basement, through a specially devised trap. Here it may be used as warm water, or it may be used for warming fresh air; in this case it is passed into coils of pipes set in a brick chamber; into this chamber cold air is admitted from outside of the building, as in the air-furnace, and coming in contact with the coils of pipes containing the hot water, abstracts the remaining heat, and passes up, through the registers into the rooms above, as warm, pure air, while the water, now cold, passes into the tank, for future use if required.

Holly's steam-trap, by which the water of condensation is permitted to escape from the steam pipes, whilst the steam is retained, is a most simple device. The trap is a vertical cylinder, which can be placed either in connection with the junction and service boxes in the mains or in the houses at the bottom of the return pipe from the radiator. In this cylinder a bucket is suspended by means of a lever. This lever is connected with a valve, which leads into an escape-pipe, carried from the bottom of the cylinder. When the end of the lever, to which the bucket is attached, is in its normal position, the valve is closed; but when this end is raised, the valve is opened. When the condensed water from the steam rises in the cylinder, it causes the bucket to rise, and to push up the end of the lever; this opens the valve, and the water below escapes. The bucket falls again, when the water sinks in the cylinder, and closes the valve before the level of the water is sufficiently reduced to allow the steam to follow.

The heat supplied through the agency of steam can, moreover, be utilised for warming water for domestic use. This may be effected, either by passing a coiled steam pipe through a cistern of water, or by turning the steam direct from the steam pipe into a jug or bucket of water, through an apparatus attached to a flexible tube, and resembling the rose of a watering pot, but with very minute holes, to prevent noise. The heat of the steam at a low pressure may also be utilised for cooking, stewing, boiling; and vegetables can be cooked with the steam at the pressure at which it is supplied for warming purposes. But to *brown* meats, *broil* beefsteak, and form the crust of bread, requires a temperature of not less than 300° to 420°, being an amount due to a steam pressure varying from 60 pounds to 350 pounds.

Steam ovens have been long in use. Mr. Loftus Perkins brought a steam oven for baking bread to the notice of the Government during the Crimean War, and cooking by this means has attained considerable development. But for this, steam at a high pressure is necessary.

Mr. Holly states that a stove, invented by Dr. Silsbee, superheats the steam for purposes of baking, broiling, and roasting. This stove is made of iron, encased in wood, with single and double ovens, and of various styles. The ovens and top are used precisely as in other stoves. The stewing, boiling, and cooking of vegetables is conducted with the steam at low pressure; but when it is desired to bake, broil, or roast, or heat flat irons, it is only necessary to cut off the communication with the steam supply-pipe, leaving the steam in the oven, and to light an argand gas-burner, or, in the absence of gas, a gasoline or coal-oil lamp; and in a short time the steam that already surrounds the ovens at 212° becomes superheated to the temperature desired, as indicated by a thermometer, and the cooking is done in the usual manner as in other stoves and ranges. In order to leave nothing to the ignorant or careless discretion of an attendant, an automatic thermostat is arranged to control and regulate the temperature. Superheating must be resorted to for the purposes named; other culinary and domestic processes can be conducted with the low pressure steam.

Mr. Holly states that the tests to which this stove has been subjected, show that it performs the duty of the best cooking stoves in use, without inconvenience and annoyance, with satisfactory results, and in a short time. For example, the average time for roasting meats by this arrangement of superheated steam is stated to be 12 minutes to the pound. Bakers require 30 to 40 minutes to bake 1¼ pound loaves in ordinary ovens; the superheater bakes 1¼ pound loaves with greater uniformity and certainly. A 2-pound steak is broiled in 8 minutes; mutton chops in 4 minutes; oysters are broiled in 4 minutes; a 12-pound turkey required 2 hours to roast; 8 pounds of roast beef, 1 hour; 1 gallon of coffee, from cold water, 8 minutes; light biscuit or buns, 8 minutes; potatoes were baked in 28 minutes.

I have not seen this cooking stove; but if it is as satisfactory as the description implies, it would seem that if combined steam-heating were introduced into houses, the occupier of a house would be enabled to dispense entirely with fires in the house, and thus be relieved from all the trouble, difficulty, expense, and dust and dirt incidental to their use.

The cost of the fittings in a house fall, of course, on the consumers. The cost at Lockport is stated as follows:—In a moderately-sized eight-roomed house, the expenses have amounted to about 150 dollars, or a trifle over £30; and in a large house, with more expensive fittings, 500 dollars, or about £100. But in applying this system to houses, it may be observed that the manner of applying the heat may be varied according to circumstances. If desired, fresh air may be heated by means of steam pipes in the basement, and conveyed by ducts in the walls to the various rooms, or radiators might be devised to warm the walls of the rooms, so that the unpleasant effect of cold walls and warm air in a room would be obviated. Coils of pipes might be arranged so as to heat flues, or the steam might be applied to work a fan for the extraction of air, and by these combined means, a ventilation as perfect as, and possessing more regularity than that resulting from open fire-places, might be easily ensured. These are all arrangements which would necessarily be left to the individual householder to arrange for himself. The heat supply may be utilised for purposes of ventilation, as well as for purposes of warming, with very little difficulty.

In discussing the degree of economy effected by the arrangement, the consideration of the collateral consequent saving of labour must be allowed due weight. In a moderate-sized house the annual consumption of coal will not be less than twenty tons; these are stowed in the cellar, and then carried thence in scuttles, which hold about 28 lbs. each—that is to say, at least 2,000 separate coal-scuttles full have to be taken to various parts of the house, the ashes brought down again, and much labour devoted to removing the dust, with which an open fire covers the furniture. In a moderate sized house, the complete use of steam would enable, probably, one female servant to be dispensed with. In artisans' houses, the saving of trouble, by having no fires to attend to, no grates to clean, and no coals to carry, would be of much value. In addition to this, each fire deposits much soot in the chimney, which at regular intervals is pushed up into the air by the chimney-sweep, and thus distributed through the neighbouring houses, rendering continued cleaning necessary, and compelling a large annual outlay in re-painting and re-decorating. There is also a great inconvenience to street traffic, caused by distributing coals to every house in every street.

The published reports do not furnish any satisfactory data by which the economy of the system can be tested relatively to other methods of heating. The following facts, however, are taken from the published reports. When the Holly Steam Combination Heating Company commenced operations at Lockport in 1877, in the absence of all previous experience as to the cost of manufacturing and distributing steam, the company supplied heat at a price equal to the previous average cost of coal to each consumer, with satisfactory results to all concerned. As an example, the school-house measured 105,000 cubic feet of air space to be heated. The average annual cost of fuel, labour, repairs, &c., had been about £130; of this £60 was for the item of coal. The company therefore agreed to maintain a temperature of seventy degrees from eight o'clock a.m. to six o'clock p.m. for £60, and the warming and ventilation of the building gave entire satisfaction to the trustees and the pupils. It is stated that experience, thus far, rather tends to diminish than increase the expense of steam-heating; and that the company have reduced their charges for heating that school-house to £54 per annum.

It was regarded as no small item, by the first year's consumers, to be saved the annoyance of handling coal, ashes, kindling, &c., also the expense of stoves and repairs; but further experiment has led some steam companies to lump their charges for steam at 8s. per thousand cubic feet of air space per annum, which was found to be a still greater economy; but upon the introduction of the meter made to register about that rate, a further saving might be effected by cutting off radiators in upper rooms, parlours, &c., when not in use, and paying only for the steam actually consumed. Thus, a house of 60,000 cubic feet contents, which is about the capacity of a good class London house, would pay about £24 a year for heat; whilst an artisan, in a model dwelling, which occupies probably from 6,000 to 8,000 cubic feet, would pay from £2 4s. to £3 4s. for heat a year, equivalent to from 10d. to 1s. 3d. a week. This is in the United States, where the winters are intensely cold, and where a very considerable amount of heat is necessary during the whole winter. On the other hand, if the steam were paid for by meter instead of by the cubic space, individuals using it might effect a reduction of cost, by cutting off the steam from the radiators in unoccupied rooms.

In Detroit, the company for heating by steam also supplied engines with steam for power. The experience of Detroit, as already mentioned, demonstrates the fact that 60 lbs. pressure could be maintained in four miles of 10-in. and 6-in. pipes, against the drafts for power and heat along the line. The last accounts which the author has seen from Mr. Gordon Lloyd, the engineer of the Detroit Company, states that the company heated a variety of buildings, stores, offices, two banks, one publishing office, one boot and shoe manufactory, &c., belonging to nineteen distinct owners, with an aggregate cubic capacity of 3,300,000 feet, in addition to which it furnished power to eight different establishments, varying from 2 to 65-horse power; in the aggregate, 196-horse power.

The cost last year was about the same as that of private heating, but it would be less on a more extended scale, provided the consumers be not too scattered, necessitating an undue proportion of street main. It is not practicable in cities to return the water of condensation to the boilers, which generally is a great economy, and would be done in all private or isolated cases. Mr. Lloyd, however, considers that the combination of heating with the supply of steam-power is not advisable, because, whilst the pressure required for the latter is at least 50 lbs., for heating purposes from 3 lbs. to 5 lbs. would suffice.

If, however, the company which supplied the steam for heating was so located as to be able to supply some factories close to its boilers, and then to apply the steam which had been used for their engines for domestic purposes, considerable advantage and economy might result. And it would be an enormous convenience to a very large number of trades, to shops, to hotels, and to many other places, for a supply of steam to be at hand for working lathes and other small machines, for lifts, and other labour-saving appliances.

The broad principle which the Holly Steam Combination Company has enunciated is that of furnishing heat from a central source o supply, applicable to all domestic purposes, just as gas and water are now supplied; and a list of thirty towns in the United States has been published, in which it is stated that this system is now being applied. It has therefore attained a practical development.

There are, doubtless, many advantages in the open fire-place, amongst which we may class its radiant heat, which warms us whilst it allows us to breathe comparatively cool air; its ventilating power; and the comfort which enables each occupant of a room, by selecting his position, to regulate according to his wishes the amount of heat he derives from it; and no one can feel more strongly than I do how great a loss its abolition would be.

But on the other hand, with ingenuity and care, it would be quite possible to devise arrangements, in connexion with steam heating, which would possess many of the advantages of an open fire; of course, the cheerful blaze could not be replaced; but when it is considered how much our open fire-places do towards polluting the air of a large town with smoke and soot, and all their concomitant evils; when we consider that London, which now numbers nearly 4,000,000 of inhabitants, will, at its present rate of increase (a rate which has not varied since the beginning of the century) number nearly 8,000,000 in 1920; when we consider what a vast amount of labour to the community is entailed by the use of an open fire in every room, in the carriage of fuel, the cleaning of grates, and the dirt arising from the air polluted with soot; when we consider that these evils are being daily intensified by the rapid increase of London, and that most of these would be avoided if our supplies of heat were laid on from a central source, we cannot but feel that our advancing civilisation, and our large congregations of dwellings, require, therefore, the adoption of some system for the supply of heat, which will enable us to dispense with separate supplies of coal to each house. The Combination Steam-heating System possesses many advantages, and in the rapid extension of houses which is continually taking place round our large towns, it is to be hoped that a trial may be given to the system in this country.

DISCUSSION.

Mr. **Cottrell** asked if Captain Galton had any statistics as to the health of the population in Detroit, or other places where this system had been employed. He had known a case where Mr. Perkins's principle had been employed in a large house, with anything but satisfactory results to the health of the family, though as far as warming, it was very efficient.

Mr. **Jennings** did not wish to deprive Mr. Holly of any merit due to him, but at the same time he wished to observe that it was not new. The system could be seen in operation at the Police Orphanage at Strawberry-hill, where it had been for a year and a half. He was consulted with regard to heating the building by Mr. Vincent and the committee, who had received tenders for warming, by hot-water pipes, the dormitories, in which 50 children were to sleep. He protested against such a system, because it warmed the air over and over again, and he proposed to introduce fresh air from outside at a temperature of 60°, and offered to take the amount of the lowest tender if he were successful; if not, to charge nothing. During the whole of last winter the wards in which the children slept were filled with warm air by two 15-in. pipes, and six weeks after the work was finished, he received a letter from the head-master saying it was most satisfactory. If, in every corner of the room they were in, there were a 15-in. pipe introducing fresh air, he thought it would be a great advantage. Fifteen years ago Mr. Talbot Vaux, Surveyor to the City of New York, sent him over a machine for warming buildings by means of steam, consisting of a series of triangular pipes, through which steam passed to warm the air, and he warmed a large mansion in that way ome years ago most satisfactorily.

Mr. **Hugh Clements** regretted there were not more details given as to the cost. There could be no doubt of the advantages of the system described, in many ways, from economy of labour, and other circumstances. He supposed the pipes in the interior of the house would be uncovered, so as to allow free radiation, but he thought a temperature of 75° was too high; 55° or 60° was quite high enough for health and comfort. In this country houses were sometimes heated by warm air driven in, and ventilation was thus secured, which was very necessary.

Mr. **E. C. Robins** suggested that the mode of heating individual buildings was rather beside the question, which was the American system of heating towns or villages from a common supply by means of steam. This was something novel, which had not been introduced here, and he should be glad if anyone who had had any experience of it would state the results.

Mr. **Loftus Perkins** said he had had no experience of the combination system, but he thought it must be a mistake as regards cooking. He did not believe super-heated steam was any good for baking; you might as well heat air as steam for that purpose. It was well known that you could bake with either steam or hot water, if the temperature were high enough. As to the combination system, he should like to have the contract for laying down the pipes, for he fancied it would be a work of considerable magnitude.

Mr. **Schönheyder** doubted whether the ventilation was at all perfect under this system as carried out in America; for a friend of his, who had lately been there, told him that there was no proper ventilation in the houses, though they were very warm, in fact, too much so for English people. He did not understand from the paper that ventilation was at all provided for. In most hot-water apparatus, as soon as you lowered the amount of heat supplied, you also lowered the amount of fresh air, and this was a great defect. As to the relative cost, it appeared, from the few experiments quoted, that large buildings could be heated as cheaply as with coal, or more so, and as that comparison was made in America, where fuel was generally used in stoves, and less wastefully than in England, the advantage would be still more apparent here, where so large a proportion of the heat went up the chimney. He differed from Captain Galton as to the ventilation in a room with an open fire-place, for in his opinion it only took place on the floor level, and did not rise higher than one's boots. He had several times taken the temperature in his dining-room with a large fire and the gas burning, and found a difference of 13° between the floor level and the ceiling. No doubt many would miss the open fire-place, but the reason people went to it so much was because they were cold, on the same principle as a hungry boy looked into a baker's shop-window, and if they were comfortably warm, they would not care about the fire.

Mr. J. A. **Coleman** said he had had the honour of reading a paper before the Society of Arts as far back as February, 1875, on a similar subject; and when he visited America a year or two ago he went to see Mr. Holly's system and examined it very thoroughly. A company having several mills in one enclosure would not think of putting a battery of boilers in each, but would collect them at a central point and distribute the steam; it was equally practicable to distribute the steam to a whole town. As to the lack of ventilation ascribed to the system of steam heating, that was a matter for each individual to arrange for himself; some did not provide it, but others had the radiators in the basement, with air conduits from the street, and the fresh air thus warmed was conducted into the rooms above, and this was a much superior plan. The fresh air which was always coming in had to go out again, and thus ventilation was provided for. It was apparent that the economy of this system must be very great, if the one question of condensation in the pipes was settled; and that had been very fully settled. Fifteen or twenty years ago steam was carried 800 or 900 feet in pipes placed on posts in the open air, and protected in a very simple way; and large steam-engines were driven by the steam passing through the pipe. Mr. Holly showed him his method of covering the pipes, which differed somewhat from that suggested in the paper he had referred to, which was to enclose them in any good non-conductor, such as sawdust and lay them in brick conduits, so that they might be got at without tearing up the streets, and with a waste-water pipe at the bottom of the conduit, to return the water to the boiler where practicable. Mr. Holly told him, two years ago, that in a mile of pipe he lost less than four per cent. by condensation, which was quite insignificant; but even that figure seemed to be now reduced. With regard to the cost of heating buildings, the figures quoted would hardly convey a true idea to an English mind, because there were no winters here such as they had in America. Last winter was considered very severe in England, but in America it would have been considered very ordinary winter weather. When investigating this subject, he took a large building like A. T. Stewart's in New York, treated it as a box containing so many cubic feet, found what the coal and engineering bills were, and distributing the amount over the cubic capacity, found that the cost averaged by the then existing methods from ·87 to 1·3 cents per cubic foot per annum; while under the system he proposed the cost was reduced, to speak roughly, by about 50 per cent. He remembered open fires in America in his boyhood, and they were always a nuisance, from the dirt and dust they created; it was the same in a lesser degree where an open furnace in the basement was used for warming the building. The saving of labour, and the advantage of being able at any time of the night, if you were ill, by simply turning on a cock, to get the heat you required in a few minutes, must be apparent at a glance. Mr. Holly told him that the difference in the wear and tear of furniture was already very appreciable. If gas works had to be put up in every private house, gas would be almost too expensive to use, but when gas was manufactured on a large scale the result was, that even with all the progress of electricity, up to the present time, it continued to be a very profitable branch of manufacture. The same principle applied to steam. When he took out his first patent, the patent authorities at Washington told him that the system of heating cities by the use of steam ranked next to the introduction of gas and water. The idea of the whole system which had been floating in his mind for years, took definite form on the night of the Boston fire. His first idea had been to devise a system for protection against fire, and the importance of that subject might excuse him saying a word or two upon it. Both there and in America, buildings had grown out of the reach of the fire apparatus, on account of their height being such, that however powerful the fire-engines, the hose would not stand the required pressure. The consequence was, he adopted for warehouses a system of iron sprinklers, such as are in use in large mills. The sprinklers were connected with a main water pipe in the street. An improvement had since been made on this system by fixing pipes on the ceiling having caps every ten feet in length. These pipes remained full of water; a heat of 160° would release the caps, and the pressure of water from a tank on the roof would throw a spray over 100 square feet. If the fire extended farther, another cap would be released, and give an additional shower, and it was only in very severe cases that recourse had to be made to the mains in the street. As they could not depend in all cases on the city fire-engines, the collection of boilers in a central place for supplying steam, gave the power, ready at any time, to work the auxiliary pumps.

Mr. **Wolstencroft** said there was a somewhat similar automatic apparatus for quenching fire exhibited in Manchester in 1875. Heating by steam had many objections. Captain Galton told them the pressure in the mains was 60 lbs., but in order to maintain that, the boiler must be made of such a character that it would not have so large an amount of heating surface as could be obtained in a hot-water boiler, and there would be a large quantity of heat wasted up the chimney. With a hot-water apparatus with one square foot of heating surface, you could heat 24 ft. of 4-in. pipe, and utilise the heat so effectually that you could bear your hand in the chimney. Mr. Hood allowed 50 ft. of pipe for each square foot of boiler surface, all the heat being absorbed as fast as it was generated. The question of condensation again was a very serious one; if, from any cause, there was not sufficient steam, the whole of the pipes would become cold, but in hot-water apparatus the circulation went on even after the fire had gone out. It would also require a great deal of expense in the matter of joints and connections to provide for expansion and contraction.

Sir FREDERICK BRAMWELL said it had been very properly remarked that the question before the meeting was what he might call the wholesale warming of cities, not the mode of warming individual buildings. There could be no doubt that the operation of wholesale warming could be carried out in the way suggested, even in the absence of experiment; but experience had also, it appeared, demonstrated the feasibility of the process. But then came the question whether it would be worth while to suggest such a system in England; and, further, whether steam was the best vehicle to employ for the purpose. The answer to the first question depended on how it would be viewed by the public, and on how many years it would take to convert them from their faith in open fires to a belief in warming by steam. He, for one, was too old a dog to learn new tricks, and he did not think he should ever be converted to any system which did away with that which he had so frequently called the visible pokeable fire. He did not think with Mr. Schönheyder that they always went to it because they were cold, in the same way as a hungry man went to a baker's shop, but he believed there was a companionship and a delight about the appearance of the flame which led them to it, wholly irrespective of the temperature. In fact, a man would sometimes urged by this motive, continue to sit nearer to a fire than was comfortable, so far as mere consideration of warmth were concerned. It had been said that the open fire was nota source of ventilation, except to our boots; and there was no doubt that if people would burn gas in their rooms—which he never would—the atmosphere near the ceiling was very unpleasant; but when sitting, the head and nostrils were not more than 4ft. or 4ft. 6in. from the floor, and there was always a considerable quantity of fresh air coming in from ill-fitting doors and windows above this level, and such an inflow would not by any means be certain if the rooms were heated by any of these contrivances. It was quite true you might use an apparatus of this kind, and have fresh air also; but you might use them without fresh air, and he feared that in many cases where heating apparatus and not open fires were used, and persons did not reflect, ventilation would suffer. It was only right for him to state, after what had been said about Mr. Perkins's apparatus, that he had it fitted up in his own house about ten years ago, and he was so pleased with it, that when, five years ago, he went to another house, he had that fitted on the same plan, but he had taken care to have a constant stream of air from the outside of the house, brought over the heating pipes, which both warmed and ventilated. In 1880, he advised Lord Spencer, the President of the Council, to adopt it, and Lord Spencer had since expressed his gratitude to him for the suggestion, saying he was sure it had saved him from a severe illness. Coming back to the real subject of the paper, the question occurred to him, if they were about to lay on heat wholesale, could it not be done more economically in the shape of gas? So many cubic feet of steam contained so many heat units, and so many less cubic feet of gas contained the same; the gas pipes were already in existence, and there was no doubt gas would become cheaper as the by-products were more fully utilised. The transport of gas through mains did not entail any loss from condensation, whilst there was some in the case of steam. He did not wish to be understood as attaching much importance to the condensation in well-clothed pipes, as it was well known steam could, under these circumstances, be usefully carried for very considerabla distances. As long ago as the opening of the Manchester and Liverpool Railway, steam was conveyed through a pipe 400 yards long to work a winding engine, and many years ago a steam-pipe, several hundred feet in length, supported on props, was used in the Doncaster-yard to work the pumping engines. There was no difficulty in transporting steam; it should be remarked, however, that the loss was constant, so that the per-centage varied with the demand on the pipe; then the difficulty in the outset would be that, unless there were a considerable number of customers, there would be a large loss compared with the steam used. As he had already said, it was, if wholesale heating were to be carried out, a question which lay at the root of the subject to ascertain whether steam or gas were the better agent to be employed. He was very sorry that Captain Galton could not give the details of the steam meter and the regulator valve; these would require very nice arrangement, and he should much like to have heard the particulars. The steam trap for the condensed water was a very old contrivance, as old as his apprenticeship to engineering. The difficulty was that if the floats leaked they became water-logged and failed to act, and a far better contrivance was one invented some 15 years ago: it consisted of a closed vertical cylindrical vessel, having a pipe at one side to bring in the condensed water, and another pipe issuing out also at the side, but close to the top, to take away the condensed water, when allowed by the valve to be mentioned later to do so. This second pipe extended horizontally to the centre of the vessel, and was there turned downward to within an inch or two of the bottom of the vessel, and was joined at its lower end with a valve seat. Within the vessel was a smaller vessel, a plain cast-iron cylinder with a bottom, but without a top. This second vessel was the float, and it was finished on the upper side of its bottom with a valve, which when the float was up, closed the valve seat at the bottom of the outlet pipe.

As long as the water of condensation was confined to the space below the float and to the annular space around it, it kept the float upward and the valve closed, but when the water accumulated, it overflowed into the cavity of the float, and thereby loaded it so as to lower it a fraction of an inch, opened the valve, the steam pressure at once blew out the water, and this relieved the float of its load, which thereupon ose and re-closed the outlet opening.

Mr. WELCH said this subject involved a great many details, all of which must be successful, and therefore it was not sufficient to discuss it merely as a whole. He had given a great deal of attention, in conjunction with Mr. John Roger, to the subject of heating by steam, but it was on rather a different principle to the one described. They found that when the pipes were heated by steam alone, there was to some extent a disagreeable odour, and they, therefore, set about to have the pipes filled with water, which should be heated by steam. The difficulty was, in the first place, the noise made by the globules of steam being condensed, and then the construction of a steam jet of such a kind that the steam should be condensed quietly in the water, and yet give such a velocity to it as to cause it to circulate. They had been quite successful in this, and had now an arrangement by which they could use steam of any pressure. from 5 lbs. up to 100 lbs. if necessary (about 50 or 60 lbs. was the best), and by an exceedingly small steam-pipe, ⅛ in. bore, keep some 100 ft. of 4 in. of hot-water pipe in very rapid circulation. By that means they could heat the water to any required temperature from 50° up to 212°. A thermostat could be used if desired, but they found a small regulating valve sufficient. The same kind of jet could be used for heating water in a tank or other vessel. The total heat of steam increased with the pressure, and as its sensible heat increased, the increase of latent heat was ·305 of a unit for every degree of sensible heat; so that, in point of fact, as the steam increased in pressure, the latent heat was reduced to the extent of ·695 of a unit. He agreed with Sir Frederick Bramwell that heating by steam might be made to act in conjunction with very efficient ventilation; in fact, when properly arranged, it was perhaps the most perfect ventilating apparatus which could be devised. With regard to an automatic fire-plug, he remembered seeing one at King's College in 1860, only it was made of wood driven into the end of the pipe.

The CHAIRMAN, in proposing a vote of thanks to Capt. Douglas Galton, said this question was not a new one in the abstract, for heating by steam had been carried out to his knowledge forty years ago. But there was a novelty in the proposal to generate steam in large volumes, at high pressure, at certain centres; and to send it at that high pressure for miles under the streets. It was also perhaps a novelty to divide steam by regulating and stopping valves, and supply it to individual houses, so that it might be used for the various purposes mentioned. The great question which presented itself was, would such a pipe be trustworthy; could it be laid and maintained for this purpose without danger and without trouble. The paper described an elaborate method of insulating the pipe to prevent excessive loss by radiation, and from the figures given it seemed to have been very successful; but it appeared to him doubtful whether, in our streets, a pipe so swelled out by insulators, and logs of wood, and planks, could be laid. The space below our streets was already so fully occupied, that the establishment of such pipes would present very great difficulties. As Sir Frederick Bramwell remarked, if they wanted to bring heat into houses, there was another means already established, and in full operation; and from a little calculation he had just made, he found that a cubic foot of coal-gas brought with it about 750 heat units, which would be about the same amount as would be supplied by 3¾ cubic feet of steam, at a pressure of 6 atmospheres. The question, therefore, would reduce itself to this, whether the one pipe or the other could be maintained with the least expense. He, for one, must adhere, for the present, to the opinion that it would be easier to supply gas than steam. The paper spoke of various modes in which steam heat could be used, and the radiator was alluded to, but he did not think that apparatus was very happily named. A steam-heated surface in a room no doubt radiated heat, but not under the same conditions as a fire-place. Probably, nine-tenths of the heat given off from that hot surface would be given off to circulating currents of air, which would pass again and again through this radiator, and a very small portion would pass by radiation into the room. The rays from such a low source of heat would hardly be felt, as radiant heat, at any sensible distance from the source. Now, he looked upon an open fire-place not only as a thing endeared to them by long habit, but he attributed to it very high sanitary qualities. The open fire-place communicated absolutely no heat to the air of the room, because air being a perfectly transparent medium, the rays of heat passed clean through it. It gave heat only by heating the walls, ceiling, and furniture; and here was the great advantage of the open fire. If the air in the room were hotter than the walls, condensation would take place on them, and mildew and fermentation of various kinds would be engendered, whereas if the air were cooler than the walls, the latter must be absolutely dry. That was the great advantage of the open fire, and it endeared it to them, though many did not know exactly where and how the comfort arose. The Americans were very ingenious, but he would not take their word with regard to the comfort of their rooms; when he was there he suffered severely from the closeness of the atmosphere of the dwellings, and when he travelled at night in the sleeping-cars he was obliged to get up four or five times and step out on the foot-board to get thoroughly cool. The only explanation he could offer was that the attendants were black men, whose standard seemed to be the interior of Africa. But although he could not agree absolutely with the proposal, yet the question of doing away with the smoke and nusiance which now resulted from open fire-places was so important, that any suggestion, backed by a considerable amount of experience, was welcome; and Captain Galton well deserved their thanks for the able manner in which he had brought the subject forward.

Mr. COLEMAN wished to explain that the figures he had given did not apply to small houses; he had calculated the cost of heating a large warehouse, including fuel for engineering purposes, elevators, and interest on the capital and depreciations of the apparatus, as he had no means of separating the items. He thought also that the Chairman's illustration of the sleeping-car was rather an extreme case, and that the better class of houses now under the modern systems would be found to compare favourably with similar houses in England as regards comfort.

The vote of thanks having been passed unanimously,

Captain GALTON said he had not the slightest intention of suggesting that heating by steam was new, but this combined system was new, and he thought deserved attention. If Dr. Siemens's estimate as to the comparative value of steam and gas as heating agents was correct, steam would be much more economical. He agreed that in towns already supplied with gas, and where the streets were filled with pipes in every direction, it would very difficult to introduce a large number of new steam pipes; but he wished that some of the companies which were building large artisans' dwellings would consider whether it would not be an enormous convenience, an economy, and an advantage in every way, to introduce such a method of heating. Of course, in doing so, care should be taken that ventilation was provided for, either on the plan Mr. Jennings proposed, or some other. No one maintained more strenuously than he did the advantage of an open fire-place for ventilation; but when they saw the enormous number of houses springing up, and knew that they could not have an open fire-place without having smoke, they ought to consider some plan for obviating the evil.

Notes on Books.

THE PHOTOGRAPHIC AMATEUR. By J. Traill Taylor. New York: Scovill Manufacturing Company.

It is said that amateur photography has taken a fresh start since the introduction of "dry plates," and probably this is the case in the United States, as well as in this country, hence may be expected to arise a demand for a book, such as the above named. Photographers who have mastered the practice of wet collodion find that there is a good deal for them to learn in the new processes, and many who have not before attempted photography are induced to do so by the comparative ease with which those processes can be carried on. It is not perhaps much easier to produce a good picture with a gelatine plate than with a wet collodion one, but the apparatus is less cumbersome, and the process is certainly much less dirty. These two facts are illustrated by Mr. Taylor's chapter on "Photography in a hotel bed-room," in which he shows how the "development" of a negative can be effected without any more extensive demands on the resources of the establishment than the loan of a jug and a pail. The book is, throughout, written on the supposition that the reader comes to the practice of photography without any previous knowledge of it. Instructions are given for the manipulation both of wet and of dry plates; printing, enlargements, &c., &c., are all treated of; and practical instructions given for the performance of these and the various other processes. Some hints on portraiture are also given, amongst them, one for taking a likeness in an ordinary room that will probably be new to many non-professional photographers. It is to place the sitter in front of a looking-glass before a window, and then take his likeness from the glass. He is thus illuminated by the full light from this window. Of course, this picture will be reversed—it will be a photograph of a reflection—but as most people do not differ greatly as to the right and left sides of their faces, this is not considered a serious objection by Mr. Taylor. It may be worth noticing that in taking a positive picture, such as the "ferrotypes" now produced at so cheap a rate, this reversal would be an advantage, as it would prevent the picture itself being—as it now is—reversed.

CHRISTMAS AND NEW YEAR CARDS, CALENDARS, &C., FOR THE SEASON, 1881-2. London: Published by Eyre and Spottiswoode.

The Queen's Printers have produced a large quantity of cards designed for them by special artists. The variety of designs is very great, as is evidenced by the catalogue in which the nature of the subjects is noted. The flowers, both separate and in groups, are worthy of special attention, as are the heads of children, the landscapes, and the naval subjects. The artists specially employed by Messrs. Eyre and Spottiswoode are Messrs. E. Maurier, Harry Arnold, and Miss Steel. There are also designs by other artists, and a series of marine views by the late E. W. Cooke, R.A.

General Notes.

OIL OF PEPPERMINT.—The peppermint crop of the United States has, for the last few years, reached the amount of 70,000 pounds per year, of which about 30,000 pounds were annually exported. Two-thirds of the peppermint oil of this country is produced in New York State, and about one-third in Michigan. The best oil comes from Wayne County, New York. The plant is a perennial one, and is planted in the spring. The next year it is ready for cutting, and generally may be cut for three years. The best yield is given in the first and second year of cutting; in the third year the plant becomes bitter. After the plant becomes four years old it is not cut, and the field is ploughed over and a new crop planted. The usual method of planting is in rows, and in August the plant is ready for cutting, which is done by mowing down with a scythe. The leaves are then placed in a still and the oil extracted. The plant is a very hardy one, and will yield from ten to thirty pounds to the acre. The cultivation of the peppermint is now being introduced into the Southern States.

PHOTOGRAPHIC EXHIBITION.—The substitution of a film of dried gelatine for the thin layer of wet collodion, which the photographer formerly employed as a vehicle to retain the sensitive salts of silver in a suitable condition on his glass plate, has involved considerable alterations in the mechanical appliances used in photography. For out of doors work, or work away from home, the photographer no longer requires to carry what was practically a portable laboratory. Not having to "develop" his pictures on the spot, he need take with him neither dark tent nor chemicals. On the other hand, he must have some provision by which his store of dry plates can be placed, one after the other, in the camera and properly "exposed" without the risk of the slightest particle of light reaching their sensitive surface, other than the light properly directed upon them by the lens. As he wishes to carry an ample supply of plates with him, and as the glass plates themselves make an appreciable burden in a long walk, it is essential that the apparatus for carrying them should be as light as possible; hence have arisen considerable improvement in the camera and its "slides." Again, the increased sensitiveness of the gelatine films makes it possible to give exposures shorter than can be effected by the hand uncapping and recapping the lens; hence the invention of numerous "instantaneous shutters," by which exposures of a few hundredths of a second can be given, and pictures of moving objects readily secured. These are but instances of the many novel appliances which recent progress in photographic science has originated, and, besides these, there has been, during recent years, many and important improvements in the applications of photography to the production of permanent illustrations for books and newspapers. All these varied applications of the art are to be illustrated by an exhibition of photographic appliances, which the Council of the Society of Arts announce will be held during January and February next, in connexion with a course of Cantor lectures to be given before the Society by Capt. Abney.—*The Times*.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Thursday Evening, at Eight o'clock:—

DECEMBER 15.—Adjourned Meeting for the Discussion of the Society of Arts' Patent Bill. The chair will be taken by Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council.

Wednesday Evening at Eight o'clock.

DECEMBER 14.—"Electric Lighting at the Paris Electrical Exhibition." By W. H. PREECE, F.R.S. Sir FREDERICK BRAMWELL will preside.

For Meetings after Christmas:—

"Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

"Stained Glass Windows." By LEWIS FOREMAN DAY.

"Photometric Standards." By HAROLD DIXON.

"Telephonic Communication." By Lieut.-Col. C. E. WEBBER.

"The Causes and Remedies of Bad Trade." By WALTER R. BROWNE, M.A.

"The Native Tribes of the Hudson's Bay Territories." By Dr. RAE, F.R.S.

"The Manufacture of Ordnance." By Colonel MAITLAND.

"Some Practical Aspects of Recent Investigations in Nitrification." By R. WARINGTON.

"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON.

"Gas for Lighthouses." (Illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM.

"The Relation of Botanical Science to Ornamental Art." By F. EDWARD HULME, F.L.S., F.S.A.

"The High-pressure Steam-engine." By LOFTUS PERKINS.

"The Industrial Resources of Ireland." By G. PHILLIPS BEVAN.

"A New Antiseptic Compound, and its Application to the Preservation of Food." By Prof. BARFF, M.A.

"Tonnage Measurement." By Admiral Sir R. SPENCER ROBINSON, K.C.B., F.R.S.

"Tools and Cutting Edges." By D. A. AIRD.

"The Teaching of Forestry." By Colonel G. F. PEARSON.

"The Art of Turning." By P. W. HASLUCK.

"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By J. L. W. THUDICHUM., M.D.

"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS, F.C.S., and Percy C. GILCHRIST, F.C.S

"Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By WILLIAM COCHRAN.

"Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. HENRY NOEL SHORE.

FOREIGN AND COLONIAL SECTION.

The Meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 31; February 28; March 21; April 4, 25; May 23.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The Meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 26; February 23; March 9, 23; April 27; May 11.

INDIAN SECTION.

The Meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 17; March 17, 31; April 21; May 12, 26.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The First Course, on "Some of the Industrial Uses of the Calcium Compounds." Four Lectures by THOMAS BOLAS, F.C.S.

LECTURE IV.—DECEMBER 12.

Other calcium compounds and their uses. The phosphorescent sulphide. Lime soaps. Bleaching powder. Phosphates of calcium. Organic calcium salts. The hardness of water, &c.

JUVENILE LECTURES.

The two Juvenile Lectures will be by W. H. PREECE, F.R.S., on "Recent Wonders of Electricity." The dates for these are Wednesday evenings, December 28 and January 4. The lectures will commence at 7 o'clock. Special tickets will be issued for these lectures.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 12....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Thomas Bolas, "Some of the Industrial Uses of the Calcium Compounds." (Lecture IV.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. Clements R. Markham, "On the Searches for the United States *Jeannette* Expedition." With a Note by Admiral Sir Richard Collinson. 2. Commodore Jansen, "On the Dutch Arctic Voyages, with Notes on the Position of Mr. Leigh Smith."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.

London and Middlesex Archæological, 4, St. Martin's-place, 8 p.m. 1. Mr. C. R. Rivington, "Records of the Stationers' Company." 2. Mr. G. H. Birch, "Roman Remains at Staines."

TUESDAY, DEC. 13...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. William Henry Wheeler, "The Conservancy of Rivers; the Fen District of England." 2. Mr. Arthur Jacob, "The Conservancy of Rivers; the River Irwell."

Photographic, 5a Pall-mall East, S.W., 8 p.m.

Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Discussion on the Rev. R. H. Codrington's Paper, "The Melanesian, Malay, and Polynesian Languages." 2. Mr. M. J. Walhouse, "Some Vestiges of Girl-Sacrifices, Jar-burial, and Contracted Interments in India and the East." 3. Mr. G. Bertin, "Origin and Primitive Home of the Semites."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. R. Clements Markham, "The Whale Fishery in the Basque Provinces of Spain." 2. Messrs. J. J. Lister and J. J. Fletcher, "The Condition of the Median Portion of the Vaginal Apparatus in the Macropedid

Royal Colonial, The Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. The Hon. T. Risely Griffith, "Sierra Leone: Past, Present, and Future. '

WEDNESDAY, DEC. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. H. Preece, "Electric Lighting at the Paris Electrical Exhibition."

Graphic, University College, W.C., 8 p.m.

Public Analysts, 79, Great Tower-street, E.C. 1. Dr. Pupre, "Some Observations on the Permanganate Test." 2. A. Wynter Blyth, "A New Method of Testing for Alum."

Microscopical, King's College, W.C., 8 p.m. 1. Mr. A. D. Michael, "Further Observations on British Oribatidæ." 2. Mr. W. H. Symons, "A Hot and Cold Stage for the Microscope."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Royal Society of Literature, 4, St. Martin's-plac W.C., 8 p.m.

THURSDAY, DEC. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on the Society of Arts' Patent Bill.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. P. M. Duncan, "Some Points in the Morphology of the Test of the Temnopleuridæ." 2. Prof. W. R. McNab, "*Abies Pattonii*." 3. Dr. Geo. E. Dobson, "The Digastric Muscle; its Modifications and Functions." 4. Dr. Maxwell Masters, "New Species of Cotton *(Gossypium)* from East Tropical Africa." 5. Rev. R. Boog Watson, "Mollusca of the *Challenger* Expedition." (Part XI.

Chemical, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 7 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. H. Mitchell Whitley, "Railway Working and Management."

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FRIDAY, DECEMBER 16, 1881.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The fourth and concluding lecture of the course on "Some of the Industrial Uses of the Calcium Compounds," was delivered by Mr. Thomas Bolas, F.C.S., on Monday, 12th inst., when special attention was drawn to the phosphorescent sulphide, lime soaps, bleaching powder, phosphates of calcium, organic calcium salts, and the hardness of water.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, Dec. 28th, and Jan. 4th, by Mr. W. H. Preece, F.R.S., on the "Recent Wonders of Electricity." The lectures will commence at seven o'clock. As in former years, admission will be by ticket only, and no member can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. Members who require tickets should apply at once, as the greater part of the tickets are now disposed of.

PRACTICAL EXAMINATION IN VOCAL & INSTRUMENTAL MUSIC.

The next Examination in London will be held at the Society's House during the week commencing 9th of January, 1882. Examiner, John Hullah, LL.D.; assistant examiner, W. A. Barrett, Mus. Bac. Oxon. Particulars will be forwarded on application to the Secretary, Society of Arts, John-street, Adelphi. No names can be received after the 27th December, 1881.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, 14th of December, 1881; Sir Frederick Bramwell, F.R.S., Chairman of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Ames, Louis, 51, Cadogan-square, S.W.
Basevi, Major, C.E., R.A., 40, Upperton-gardens, Eastbourne.
Cox, Frederic John, Ferndene, Sidcup, Kent.
Fearnley, James Baldwin, 65, Carlton-street, Castleford, Yorkshire.
Graves, Edward, 126, King Henry's-road, N.W.
Griggs, William, Elm-house, Hanover-street, Peckham, S.E.
Harvey, Frederick, The Grove, Wandsworth, S.W.
Johnson, Charles Edward, Morven-house, Steele's-road, Haverstock-hill, N.W.
Johnson, Edward H., 57, Holborn-viaduct, E.C.
Richardson, Charles, M.I.C.E., 10, Berkeley-square, Bristol.
Robinson, Hugh Cecil, A.M.I.C.E., 6, Westminster-chambers, S.W.
Seaward, George, Aberdeen-lodge, Worple-road, Wimbledon.
Stacy, Jonathan Sargeant, Olive-cottage, Hatherley-road, Sidcup, Kent.
Ward, Thomas Alfred, 10, Rathbone-street, Canning-town, E.

The following Candidates were balloted for and duly elected Members of the Society:—

Ashford, Charles Arthur, 76, Upper-street, Islington, N.
Bennett, Charles Thomas, Bristol.
Buckney, Thomas, 61, Strand, W.C.
Catherwood, William Bailey, 87, Gower-street, W.C.
McHardy, Captain Alexander Burness, R.E., 8, Gloucester-street, S.W.
Moulton, John Fletcher, F.R.S., 11, King's Bench-walk, Temple, E.C.
Parkinson, Gilderdale John, 307, Moseley-road, Birmingham.
Pillow, Edward, A.M.I.C.E., 162, Wistaston-road, Crewe.
Sale, Major Matthew Townsend, R.E., C.M.G., 27A, Old Bond-street, W.
Saxby, John, Canterbury-road, Kilburn, N.W.
Stephens, George, 20, York-road, Leamington-park, Acton, W.
Thwaite, Benjamin Howarth, F.C.S., Bolton, Lancashire.
Vibert, Arthur Reginald, 7, South-square, Gray's-inn, W.C.
Wallis, Charles, Sister-house, Clapham-common, S.W.

The Paper read was—

ELECTRIC LIGHTING AT THE PARIS EXHIBITION.

By William Henry Preece, F.R.S.

The recent International Exhibition of Electricity in Paris marks an epoch in the history of the practical applications of that science to Arts, Manufactures, and Commerce. I purpose to-night to refer only to its application to artificial illumination; but there are many other branches fully deserving examination and discussion by this Society. It was, however, as an exhibition of electric lighting that it was principally attractive, and those who saw it for the first time will never forget the vivid impression that the great blaze of splendour produced upon their minds on entering the building. There never can be anything like it again, for as wisdom grows with experience, so no manager of any future Exhibition is likely to repeat that terrific *mélange* of lights that flooded the interior of the Palais de l'Industrie with great brilliancy, but with an impracticable and impossible means of comparing and judging the relative merits of different systems.

For instance, at the forthcoming Exhibition at the Crystal Palace, the building—splendidly adapted for the purpose—will be divided into sections, each section being lit by one, and only one system. But at Paris, Pelion was piled upon Ossa; the British Section, for instance, received rays from at least a dozen different sources. To estimate the value of a Siemens lamp you had to eliminate the disturbing influence of a blazing Crompton; and to admire the star-like Jaspar arc, you had to run the gauntlet of a flock of Swans. The fretful Jamin, or the fitful Jablochkoff, was masked by the steady Gülcher or the brilliant Serrin. In the galleries, however, it was different. Here, different *salles* were illuminated by different systems; a small theatre was lit by the Werderman lamp, and a picture gallery most effectively shown up by the *Lampe Soleil;* a buffet was softly and brightly lit up with the Swan lamp, while Mr. Edison's numerous exhibits, in his own *salons*, were as visible by night as by day, thanks to his own beautiful lamp.

It is not my intention to examine, *seriatim*, the various machines, lamps, and modes of illumination shown. With most of them, you are already familiar. But I purpose to select what appeared to me to be novelties, and what seemed worthy of being brought to your notice, as steps in advance.

On the night of August 29th, there were in operation 277 arc lamps, 116 candles, 44 arc incandescent lamps, 1,500 incandescent lamps, or a total of 1,837 electric lights in all, at the Paris Exhibition. Towards the end of the period during which the show was opened, this number was very largely increased, and I have little doubt that the number reached 2,500 in the beginning of November. Now this army of lamps required power to convert the energy stored up in coal into energy of motion; dynamo-machines to convert the energy of motion into electrical energy; conductors to transport this electric energy to the point to be illuminated; lamps to convert the electric energy into energy of heat, and therefore of light.

The exhibition of engines and machinery was very extensive, although our English manufacturers failed to do what they might have done had they thought as highly of the Exhibition at first as they did afterwards. Many of our manufacturers were conspicuous by their absence. The only extensive display was by Messrs. Robey and Co., of Lincoln, who showed eight of their well-known engines, with a total power of 250 horses, and I have every reason to believe that their success has amply repaid them for their enterprise. Mr. Brotherhood made a small show of his well-known three-cylinder engines and Messrs. Wallis and Stevens, of Basingstoke sent one of their semi-fixed steam-engines, with their pretty and effective governor for adjusting the speed while in motion—uniformity in speed being an essential criterion of an electric-light engine. The foreigners, for a wonder, far outshone the British in the magnitude of their displays.

One of the most valuable exhibits was made by Messrs. Thomson, Sterne, and Co., who showed a new gas-engine on a new principle, which attracted a great deal of attention. Gas is destined to play a most important *rôle* in the future of electric lighting. Its function is that of a heat-generator. The energy of the coal exists in gas in a form which can develop more light, when converted into the form of electricity, by the current, than in the form of heat by combustion. Gas-engines have a very high theoretical efficiency, and they are free from the dangers of boilers, the neglect of stokers, or the waste of energy in chimneys.

Gas-engines on the "Otto" principle, from half horse-power to 50-horse power, were very extensively exhibited by France, but the machine of Thomson, Sterne, and Co. (Clerk's patent) excelled them all in lightness, compactness, regularity, and safety. One of these engines may now be seen at work at the Smoke Abatement Exhibition at South Kensington, and several have been ordered for private houses. As an adjunct to the gas-engine, Mr. Dowson exhibited an interesting and valuable process of making cheap gas for motor purposes. Prof. Ayrton reported that in a series of trials made with a $3\frac{1}{2}$ h.p. (nominal) "Otto" engine, driven by the Dowson gas, one h.p. (indicated) was obtained per hour by the consumption of gas derived from 1·46 lb. of coal. For larger engines he anticipated a consumption of only 1·2 lbs. per indicated horse-power per hour. You will have a paper during the Session by Mr. Dowson himself, describing his mode of manufacture. When perhaps 6 lbs. of coal per horse-power per hour are consumed in the present electric-light steam-engines, you can form some idea of the economy to be effected by cheap gas.

Dynamo-machines—machines which convert the energy of motion into electrical energy, through the medium of magnetism—were exhibited in abundance, of all kinds and forms, from the original apparatus of Faraday, made with his own hands, to Mr. Edison's latest development of this wonderful source of electric currents. There are two kinds of machines—the one producing currents from fixed and permanent steel magnets, the other from electro-magnets, excited by the currents which they themselves generate. Each kind is also subdivided into two others, in one of which continuous currents are produced, flowing in one direction, called the *continuous current machine;* and in the other alternate currents, called the *alternate current machine*, where the current rapidly reverses and changes its direction. The production of currents by these machines is due to the simple fact discovered by Faraday, that if a conductor, such as a copper wire, be moved rapidly through a magnetised space, or a magnetic field, as it is called, this conductor is electrified so that, if its two ends be connected, a current flows. The intensity of this current depends, first, on the intensity of the magnetism present, on the velocity with which the conductor moves through the field, and on the direction with which it cuts the lines of magnetic force which permeate the magnetic field. The magneto-electric kind—the manufacture and invention of M. de Meritens—are very much approved of by our Trinity House for lighthouse purposes, and a very fine display of them was made by M. de Meritens, who seemed to live in the Exhibition, for he was always there, and who never seemed to tire of giving his clear and able descriptions. He exhibited alternate and continuous current machines, and he richly deserved the gold medal that was accorded to him. The exhibition of dynamo-machines was rendered very interesting by the exhibition of an early machine of Elias, of Haarlem, of 1842, and of Pacinotti's machines of 1861. The former was shown in the Dutch Section, and the latter in the Italian. Here we have the germs of all the present machines, and by whatever name a machine may be known, it can be traced back to these original types. The Pacinotti apparatus has been very greatly improved by Gramme, and by Siemens—forms well known to every one—but it has received its greatest development in the Edison machine, which was one of the wonders of the Exhibition. As this was one of the greatest novelties, I must briefly describe it. In the first place, I must point out that the machine is larger than any one that has ever been made before. It weighs, with engine and bed plates, 20 tons, and it can produce a current of electricity of nearly 900 ampères.* As the largest machine of the Gramme type weighs scarcely one ton, and produces a current of but 93 ampères, the difference becomes striking. Now, Mr. Edison has struck out three new paths, first—in the bulk and form of his electro-magnets, second—in the size and construction of his armature, and third—in the low resistance of his revolving coil. By the first, he secures an intense and concentrated magnetic field, by the second he secures a high cutting velocity for the moving conductor through this field, and by the third, he secures a very powerful current to be distributed among a great number of lamps with the least possible waste of energy. The long and bulky coils, 8 feet long, which constitute his electro-magnet, have excited the surprise of many electricians, but there is no doubt that he has arrived at this form after many careful practical experiments, supported by the mathematical investigations of Professor Rowland—a very high authority—and that the result is to obtain an intense field in a large space, with the least absorption of electrical energy in the coils. With 350 revolutions per minute he is able to produce an electro-motive force of 110 volts, which an ordinary Gramme machine can only attain with over 1,000 revolutions per minute. His field-magnets are wound with copper wire, which have a resistance of 30 ohms, and which are connected as a shunt to the main circuit, as was originally done by Wheatstone, and is now followed by Dr. Siemens and Sir William Thomson. The armature is not wound with wire, but is constructed with solid bars of copper $\frac{3}{4}$ in. by $\frac{1}{2}$ in. section, and $3\frac{1}{4}$ feet long, which are well insulated from each other, and are most ingeniously connected at their ends by copper discs, so that all the bars, of which there are 138, form one continuous circuit, whose total resistance is only 0·008 of an ohm. The diameter of the armature is 28 inches. The core of the armature is made up of 1,700 thin iron discs insulated from each other by paper, and well clamped into a solid mass by bolts. This is done to avoid the heating effects due to so-called Foucault currents induced in the metal and absorbing or wasting energy. The iron core of the armature becomes thus magnetised, and it concentrates the field to the space through which the conductor moves, as is done in Siemens's and other machines.

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* The largest Brush machine weighs two tons, and absorbs 40-horse power.

There are two great troubles in existing machines, want of uniformity in their motion and the slipping of belts. The former is met by governors, and the latter by direct gearing. Steadiness of motion is most essential, otherwise we have that painful throbbing of the light that is so irritating to the eyes. Mr. Edison connects his armature direct to his steam motor, which is a high-pressure engine of the Allen-Porter type, governed by an ingenious centrifugal regulator, and rotating very uniformly at 350 revolutions per minute, without any multiplying gear whatever. When the machine is giving out its maximum commercial effect it absorbs 125-horse power, the external resistance should be 16 times that of the armature, the electromotive force 110 volts, and the current consequently 860 ampères. It is not safe to exceed this limit, for the armature then becomes unduly heated. A special blower is added to direct cold air on the armature to keep down the heat, when the work of the machine approaches its limit. The brush is a special feature of the machine. The absence of sparking was very striking. Mr. Edison coats his brush and commutator with an amalgam of copper, which diminishes the electrical resistance of contact, reduces the heat, and prevents sparking.

Those who are interested in this machine—and everyone should be, for it is a decided step in advance—will soon have an opportunity of seeing it at work at 57, High Holborn.

There was a very interesting form of Gramme machine shown, which was maintained at a velocity of 2,400 revolutions per minute, and was said to generate an electromotive force of 2,000 volts. It maintained 60 Jamin candles alight. But one of the best and most compact forms of Gramme was that shown by the British Electric Light Company, designed by their engineer, and made for them by Messrs. Emerson, in Stockport.

The display of lamps was the display of the building. There were very few novelties among arc lamps. An arc lamp consists of two sticks or rods of carbon, which are kept apart a small fraction of an inch while the current flows through them, but which come together when the current ceases. Across the interval separating them there is a steady flow of electricity, accompanied by a slow consumption of the carbon of each rod. This flow of electricity produces high temperature, and intense incandescence and combustion of the carbon particles. This is the arc. One lamp differs from another only in the way in which the carbons are moved forward as they consume, so as to maintain the resistance equal and the right steady. Among arc lamps, that which signalled itself out among all its compeers, for steadiness and brilliancy, was the Jaspar lamp, exhibited in the Belgian Section; but it had the disadvantage of absorbing all the energy of one machine. Among those that admitted of having a number on one section, perhaps the simplest in its construction was the Gülcher, exhibited in the Austrian Section; but the most effective and original was the "Pilsen" lamp, the invention of Messrs. Piette and Krisik. It is called the "Pilsen" lamp, from the place of its birth, and from the want of euphoniousness in the names of its inventors. It was exhibited in the Austrian Section, and also in the British Section, by Mr. Fyfe. The carbons are kept apart by a sucking coil when the current flows; they are regulated by a second sucking coil worked on a shunt. The peculiarity of the lamp consists principally in the shape of the core that controls the carbon—it is wedge-shaped at each end; in action is wonderfully regular, and almost perfect. Six lamps were worked in one circuit by a Schuckert machine.

The *Lampe Soleil*, which holds an intermediate position between arc and incandescent lamps, made a very effective display in the picture-gallery, where there were 20 lamps in 10 lanterns. It is to be seen in London lighting up the Panorama in Westminster. It is a fixed, steady, durable lamp, giving a soft yellowish light, which is due to the fact that the arc maintains in incandescence a highly refractory substance like marble, between the two ends at the carbon. It is a very simple lamp, for it involves no mechanism whatever; but it is said to absorb a great deal of power, though I have seen no reliable figures of its performance. Its consumption of carbon is remarkably small. It is worked by an alternate current machine, which, like most of these machines, made a most unpleasant hum.

Carrè made a very fine display of carbons for arc lights, for the manufacture of which he is so famous, in which the regularity of form, of structure, and of composition, is said to be absolute; but it is very questionable whether this is really the case in practice, for the irregularity of the arc lights is chiefly due to impurities and irregularities in the carbon. Moreover, the very vast discrepancies that are found in the photometric measurements of the same lamp at different times, or by different persons, may be due to the irregularities in the structure of the artificial carbon rods.

No one can deny that the Jablockhoff candle has done good service in the cause of electric lighting; but I am afraid that the Exhibition in Paris has sounded the knell of all forms of candle, as well as those of the Werderman type. The rising favourite is the incandescent lamp, pure and simple. The display made by Mr. Swan in the buffet, in the Congress Hall, and in the Pavilion at the Post-office, was brilliant and effective. The light was soft, uniform, and yellow. The incandescent light is totally free from those bright rays that are so injurious to the eyes, so uncomplimentary to the complexion, and so irritating to the worker, if they are accompanied with the least unsteadiness. It is so readily under control; it requires no skilled labour to replace it or attend to it; it can be fixed anywhere; it can be worked into the fixtures and decorations of a room, and it does not damage them, as gas and oil do. Incandescent lamps can be worked by either continuous or alternate current machines. In fact, the chief lesson of the Paris Exhibition is this, that the arc light is specially suited for external illumination, and that incandescent lamps are eminently adapted for internal and for domestic illumination. This lesson has been carried into practice at the Savoy Theatre, where nothing can be more effective or more efficient than the illumination of the auditorium. One can breathe pure air, feel cool, and can sit out a play without incurring a headache. There were several incandescent lamps shown at Paris besides those of Mr. Swan, notably those of Maxim and Lane-Fox; but that which possessed the greatest novelty, and was decidedly the most efficient, was that of Mr. Edison. The distinctive character of the Edison lamp is the remarkable uniformity of its texture and light-giving power. The lamp consists of a fine filament of carbon inserted as a part of the electric circuit in a glass globe, which has been exhausted of air to the utmost limit of workshop skill. A fine, uniform quality of Japanese bamboo has been selected as that which gives the finest filament for carbonising. The bamboo is cut by special machinery into the required dimensions, and inserted in a mould, which is placed in a furnace, and raised to a very high temperature, and from which the filament comes out shaped and carbonised. Naturally grown vegetable fibre has been found to give a more uniform texture than any artificially-formed carbon. The ends are cut flat, and squeezed inside copper clamps, which are then welded together by electro-plating. The copper clamps being soldered to platinum leads that are sealed through the glass, and are connected to the conductors. Perfect sealing is obtained by flattening the mass of the tube, through which the fine platinum wires pass, into a solid bar, so as to well fuse the wires and glass together. It is a fortunate thing for the permanence of the incandescent lamp that the co-efficient of expansion, due to heat, of glass and platinum is practically the same.

The normal lamp consists of a filament 6 inches long, which gives a resistance of 240 ohms when cold, and, when permeated by a current of 0·8 ampère, gives a light equivalent to 16 sperm candles. The half lamp is constructed with a carbon filament of just half the length and half the resistance, and gives eight candles. Other lamps are made with two and with four horseshoe filaments, so as to increase the light-giving power. The features of carbon, which render it so highly adapted for incandescence, are its electrical resistance, its high refractory character, and its stability. The illumination of a filament and its durability are functions of the current that passes; the more intense the current, the higher the temperature, and therefore the brighter the light, and the shorter its life. At a temperature of about 1,000° carbon becomes red, at 2,000° it is white, and the higher the temperature, the whiter it gets, until it fuses. A current of 0·8 of an ampère maintains an Edison filament at about 2,000°, when it gives a light of 16 candles, and it lasts on an average 1,000 hours. A stronger current will give a much better light, but the carbon will not last so long. If it were possible to find a form of carbon, or any other material, which would be so refractory that we could transmit through it much stronger currents, the incandescent lamp would rival the arc lamp in brilliancy and power.

The destruction of the carbon filament in incandescent lamps is due to what is called the Crookes' effect, a very slow transference of carbon, in a molecular shower, from the one heel to the other heel of the horseshoe, until a breakdown takes place at the former point. The better the vacuum the slower this effect. Alternate current machines are said to lengthen the life of the carbons, by equalising the distribution of molecules on each heel, but they do so at the expense of efficiency.

Many devices were shown for measuring the quantity of electricity consumed in any place by electric lamps; but that adopted by Mr. Edison is sufficiently simple and accurate for all practical purposes. A glass cell contains two copper plates immersed in a solution of sulphate of copper. A definite proportion (0·001) of the current that passes through the house passes also through this cell, and removes copper from one plate and deposits copper on one plate. The weight of copper deposited is an exact measure of the current used. There are two such cells—the one in charge of the consumer and the other of the supplier. They thus check each other.

Various plans were shown in different parts of the Exhibition to diffuse the light, but the most effective was that in *Salle* 15, where a Jaspar lamp filled the room with a shadowless light, by throwing a light on to a white screen above the lamp, whence it was scattered. The lamp itself was invisible. This plan is not novel. It was suggested by the Duke of Sutherland, and has been adopted by Mr. Schwendler in India.

The proper distribution of light is a problem that remains to be solved. It is argued that an arc is so much superior to an incandescent light, that one-horse power in the former gives you ten times more light than in the latter. This is true; but, on the other hand, to obtain a subdued light sufficient for your purpose, you must either put the arc lamp far away or tone it down by shades, and therefore waste it; whereas an incandescent lamp can be toned down, by regulating the current, to any colour you like, and it can be fixed just where it is wanted. One-horse power will give you 1,500 candles in an arc, and only 160 candles in 10 incandescent lamps; but these 10 lamps can be so distributed about your space to be lit, as to illuminate your surface or objects with a better light than the arc.

Curiously enough nothing whatever was done in Paris to improve the illumination of streets. The Avenue de l'Opera, the first street practically lighted by electricity, still remains as it was in 1878; but prior to the opening of the Exhibition, a portion of the Boulevard des Italiens was lit up by four De Mersanne lamps, suspended high up, at wide intervals, over the centre of the road. The effect was very fine, but the lamps were very bad. This is the true way of illuminating streets, and it is to be regretted that such an experiment is not tried in London. Street illumination in England by electricity up to the present time is, as a rule, a questionable success.

The question remains for discussion, Has the electric light been brought within the region of practical domestics? I have no hesitation in saying that it has; but whether it can be brought into economical contrast with gas, experience alone will show. Several houses are already illuminated by its agency; others are in hand, my own amongst the number; and when we next meet to consider this subject, I may be able to answer the question with actual facts.

One word as regards the danger of electric lighting. There is no use blinking our eyes to the fact that electricity can be a dangerous servant in the hands of the careless and ignorant; in the hands of the skilled it has less danger than gas, or even oil. The installation of the wires must be controlled by experience and knowledge. I have more than once called attention to this fact, and my warnings have been received with abuse; but in Paris there were no less than five incipient fires, from the wires coming in contact with each other, in the Exhibition building. *The Times* correspondent in Vienna implies that the frightful disaster to the Ring Theatre was due to this cause. The instances in New York are so numerous that the Board of Fire underwriters have issued the following rules:—

"1. Wires to have 50 per cent. excess of conductivity above the amount calculated as necessary for the number of lights to be supplied by the wire.

"2. Wires to be thoroughly insulated and doubly coated with some approved material.

"3. All wires to be securely fastened by some approved non-conducting fastening, and to be placed at least 2½ inches for incandescent light, and 8 inches for arc lights, from each other, and 8 inches from all other wires and from all metal or other conducting substance, and to be placed in a manner to be thoroughly and easily inspected by surveyors. When it becomes necessary to carry wires through partitions and floors, they must be secured against contact with metal or other conducting substance in a manner approved by the inspector of the Board.

"4. All arc lights must be protected by glass globes enclosed at the bottom, to effectually prevent sparks or particles of the carbons from falling from the lamps; and in show-windows, mills, and other places where there are materials of an inflammable nature, chimneys with spark arrestors shall be placed at the top of the globe. Open lights positively prohibited. The conducting framework of chandeliers must be insulated and covered the same as wires.

"5. Where electricity is conducted into a building (from sources other than the building in which it is used) a shut-off must be placed at the point of entrance to each building, and the supply turned off when the lights are not in use. Applications for permission to use electric lights must be accompanied with a statement of the number and kind of lamps to be used, the estimate of some known electrician of the quantity of electricity required, and a sample of the wire (at least three feet in length) to be used, with a certificate of said electrician of the carrying capacity of said wire. The applications should also state where the electricity is to be generated, whether the connection will have metallic or ground circuit, and, as far as possible, give full details of the manner in which it is proposed to equip the building."

These rules are very simple, and are necessarily carried out by every qualified electrician, but an additional security is obtained by Mr. Edison, by inserting in every branch wire a "safety catch," which is a short piece of lead wire that instantly melts if the strength of the current exceeds a certain value, and thus ruptures the circuit, stopping the flow of electricity, and producing safety.

The completeness of Mr. Edison's exhibit was certainly the most noteworthy object in the exhibition. Nothing seems to have been forgotten, no detail missed. There we saw not only the boilers, engine, and dynamo-machine, but the pipes to contain the conductors; the conductors themselves, heavy and massive, for Mr. Edison recognises the waste of energy that must occur in small conductors, the insulation, the fixtures, the brackets, the safety catches, the lamps, devices to avoid the effects of expansion and contraction through changes of temperature, meters to measure the current used, regulators to control the consumption of fuel. In a properly regulated system there ought to be no waste of fuel. The engine driver has an indicator which shows him exactly what current is going out, and he has simply to regulate his firing by this indicator. Moreover, by the use of a rheostat, he is also able to regulate the outgoing current so that he is able to maintain a perfect ratio between the fuel consumed and the light evolved

The question that determines the size and insulation of conductors is a commercial one, and is regulated by the relative economy of waste of energy or interest on capital expended. If an expenditure of £100 per mile saves you £10 a year in fuel, it is clearly better to expend £100 on your conductor. If, on the other hand, it would save you only £2 a year, it is better to utilise your capital elsewhere. Every inch of conductor means waste of energy; the shorter and heavier it is the less the waste; but as some waste is imperative, it is simply a matter of calculation to determine which shall be wasted least, capital or fuel.

The system is self-regulating, if the electromotive force is kept constant, and the resistance of the lamps be uniform. We have the dynamo-machine at one end of the circuit, and a lamp at the other. The circuit is complete; a small current flows, which is determined by the resistance of the lamp alone, if the main conductors are made sufficiently large to neglect their resistance. Additions and subtractions of lamps only vary the resistance, and, therefore, the current. Turning off one lamp does not interfere with the rest. The limit of the number of lamps inserted is determined by their resistance, and by the heating of the armature; hence the value of high resistance in the lamps, and low resistance in the armature of the dynamo-machine. Every lamp induces, as it were, its own current. We have not a store of electricity which has to be subdivided, but we generate our energy as we want it. This is the promising feature of the system. It is a principle of multiplication, rather than of sub-division, and leads one to anticipate economy in its working. Mr. Edison's system has been worked out in detail, with a thoroughness and a mastery of the subject that can extract nothing but eulogy from his bitterest opponents. Many unkind things have been said of Mr. Edison and his promises: perhaps no one has been severer in this direction than myself. It is some gratification for me to be able to announce my belief that he has at last solved the problem that he set himself to solve, and to be able to describe to the Society the way in which he has solved it.

It may be taken as a rule, that any system dependent on the exercise of abnormal energy is certain sooner or later to break down; we all of us hate personal supervision, and personal supervision at home is a species of abnormal energy. This is the great secret of the success of gas. It is the cause of the slow progress of the arc light; but it is because the incandescent light promises to rival gas in this respect, that such a future is open to it.

The awards at the Paris Exhibition were liberally bestowed by the jury, perhaps too much so; but matters were hurried up towards the end, owing to political difficulties, and the conclusions were necessarily hasty. No proper measurements or tests were made by any jury, but a committee, presided over by M. Tresca, has since been formed to continue the work, and there is no doubt that most valuable results will be obtained, for the desire of the jury to procure reliable measurements has been very generally met by the exhibitors. I had great hopes of being able to give you the results to-night, but the reports are not yet complete.

We shall all, very soon, have a repetition on a different scale, and in a different way, at the Crystal Palace, and I have little doubt that, in its way, the Crystal Palace Exhibition will be as fine and as interesting as that at Paris.

DISCUSSION.

The Chairman said he could not open the discussion better than by calling on Mr. Johnson, the representative of Mr. Edison.

Mr. Johnson said he did not know that he could supplement what had been so well said by Mr. Preece, so as to add to the interest of the subject, but he should be ready to explain anything which had been left unexplained, and he would also illustrate, further, the use of some of the apparatus. He wished, however, to say that Mr. Edison's system was not merely a system of electric lighting; but the novelty of his system lay in this, that he contemplated the manufacture of electricity on a large scale at a central station, and its universal distribution throughout the entire area of the city where it was established, to be used by uneducated or unscientific people, without the supervision of trained experts in the employment of the company. They proposed to put the electric light into houses in such a simplified form, and with such provisions, as to render supervision entirely unnecessary; to bring the lamps within the care of ordinary house servants, no matter how ignorant they might be; and in such a way that no damage or waste was possible. The electricity thus converted into light might also be converted into power, by means of an electro-motor; and it might be utilised in a variety of ways, such as for ringing bells, &c. The annoyance of maintaining a battery, as well as its expense, had hitherto proved a bar to its general use, but when electricity could be supplied and paid for only as used, to be shown by a meter, an immense deal of work, such as driving sewing machines, &c., would be done by it. There had been a good deal of talk about a regulator, and Mr. Preece had shown that one might be made to maintain an even pressure throughout an entire district lighted from one station, no matter how many lamps were lighted by it. They preferred to have such a regulator with personal supervision, just as gas companies regulated the pressure on their mains as required, rather than employing any automatic device, which was liable to get out of order. [Mr. Johnson here showed how the amount of current could be increased or diminished at will, so that when fewer lights were in use, the quantity would be diminished accordingly.] The man in charge of the central station would regulate the current by a sample lamp kept alight there. He had been asked whether the replacement of the lamps, when used up, was expensive or difficult. In answer to that, he might say that in New York, where they were making arrangements to light up a central district of a mile square, they proposed to supply every consumer with all the lamps he might use, free from cost, simply charging the cost of the lamp in the current supplied and paid for on his meter. The first cost of the lamps was very small to them, and they therefore preferred supplying them to subjecting the consumer to the annoyance of having to purchase them. [Mr. Johnson here unscrewed a lamp, and attached another, to show the readiness with which a change could be effected.] A question had also been asked him, whether a single light could be raised or lowered; and there was a lamp made in which this was provided for, but it was more expensive and complicated, and was not recommended. There were very few cases where such would be required, because you need not leave a light on, as in the case of gas, in order to light up when required, as you only had to turn it on, and it lit itself.

Sir Henry Tyler, K.C.B., moved a vote of thanks to Mr. Preece, but remarked that the paper hardly answered to the title, inasmuch as it was mainly devoted to an explanation of Mr. Edison's lamps, and he thought there might have been a little more time bestowed upon other lamps. He was far from wishing to disparage the Edison lamp, and no one had more sympathy than he had with American inventors; but he would suggest that the title of the paper should be altered when printed.

Mr. E. Crompton said he had been much interested in the paper, but he must concur to some extent in Sir H. Tyler's remarks. Many, if not all, of the merits of the Edison lamp were common to other incandescent lamps. He, therefore, thought

Mr. Swan and Mr. Lane-Fox ought not to be passed over in silence, or Mr. Maxim, the other great American inventor. Mr. Preece had been rather hard on the arc systems, which he said had made comparatively little progress; but in reply to that, he would ask the meeting to look at the length and breadth of England, where, since that time last year, there had been from 900 to 1,000 installations of the electric light, which, with the exception of 30 or 40, were all on the arc system, and, with very few exceptions, they were all working most successfully. The incandescent systems were working equally successfully, but the whole system was an infant compared to the arc, and had not yet been worked on a sufficiently large scale to judge of its merits. It had hitherto been placed in circumstances not best suited for it. The lighting of the Savoy Theatre was a great success, in his opinion, but no one could say that that vast open space could not be lit more satisfactorily with arc lights, if good ones, and properly managed. The arc light hitherto had had to struggle with the great difficulty of getting homogeneous carbons; but new manufacturers were setting to work, and he believed the trade of making these carbons would soon become one of the great industries of the country. It required nothing but the enormous demand, now springing up, to produce splendid carbons, which would give a perfectly satisfactory light.

Mr. J. N. SHOOLBRED said he had nothing to add to Mr. Preece's description of the Paris Exhibition, but he thought his remarks as to the future sphere of the arc light and the incandescent light respectively should be somewhat modified. He did not think the arc light need be confined merely to large open spaces. It was a question of the enormous difference of mechanical energy; and a case which recently came under his notice would illustrate this. It was the interior of a building considerably larger than that hall, which it was found would require about 6-horse power to light it by the arc system, whilst on the incandescent system it would have taken nearly 40-horse power, and from 170 to 200 lights. With regard to the experiments shown that evening, he must fully concur in what had been said as to the beautifully steady character of the lights, but at the same time, it was only fair that due credit should be given to other inventors.

Mr. HUGH CLEMENTS remarked that Mr. Edison had evidently gone beyond anyone else up to the present time, in the manufacture of his 20-ton machine at any rate. Mr. Preece, of course, could not enter fully into the details of all the lights; but he understood him now to withdraw a statement he had made on a former occasion, that it was impossible for private houses to be lit up by electricity from a central station. There was evident proof that this was being done in New York, and he hoped the time would soon come when they would see the same thing in London.

Captain VERNEY, R.N., said it might be interesting to the meeting to hear the opinion of one of the general public, entirely unconnected with any electrical interest. He had visited the Paris Exhibition twenty or thirty times, and had been many times in both the Edison and Swan rooms. He must say that he came away with the impression that on the whole the Lane-Fox was the most satisfactory exhibit. He was also much impressed with the beauty of the *Lampe Soleil*, which Mr. Preece had alluded to, but not described very minutely. One of its great beauties was, that you could introduce other substances as a bridge between the carbons, and thus vary the colour and quality of the light. The light was exceedingly soft and agreeable, being generally overhead, and it seemed to him an enormous advantage to be able to introduce marble, magnesium, or some other substance, and so tone the light as to be suitable to the place to be illuminated. He hoped those who had the management of the Exhibition at the Crystal Palace, would enable the general public to gather from it more information than was available at Paris. There they were furnished with an incomprehensible catalogue, referring to numbers which did not exist, and to rooms which could not be found. It was a most perplexing thing for anyone with the average amount of intelligence and energy, to learn anything from the Paris Exhibition.

Mr. LASCELLES SCOTT did not propose to launch upon the vexed question with which the discussion opened, further than to suggest that, as Mr. Preece had on former occasions spoken rather adversely to Mr. Edison, he felt constrained now, with more information, to do him full justice. He thought the time was hardly arrived to pronounce definitely that the arc light was only suitable for large open areas, and that the incandescent system was best for internal use, or *vice versa*, because in all probability, in a few years, such an opinion would be very much modified. Judging from his own small experience, he desired to place on record his opinion that probably the domestic lamp of the future would be one in which the prominent features of both systems were combined, which would illuminate a room alternately, or almost at the same time, by either a small arc, or an incandescent lamp. There was already a system which professed to do something of the kind.

The CHAIRMAN said he thought the last speaker had really given the answer to the objection raised by Sir H. Tyler, by referring to Mr. Preece's desire to restore the equilibrium of the balance, which, on a former occasion, had been unduly depressed on one side. Passing from this matter, and going to the real subject of the paper, they had before them a remarkable example of the incandescent light, and he thought they must all agree that if this light could be introduced into houses, in the same way as gas, and at no greater, or a very little greater, expense, it would be forthwith adopted. A lamp which did not vitiate the atmosphere in the least, which gave off but a small amount of heat, which was capable of being absolutely extinguished, and then renewed again in a moment, was one which all would willingly take instead of a gas lamp, which certainly did pollute the air, heated it inconveniently, and if there were too much pressure, or the burner were out of order, smoked and spoiled the furniture and pictures. Under these circumstances, he thought it could not be doubted that if they could all, by a mere word, change their gasfittings and lights to such as they saw there, that word would be uttered; but then came the question, how near were they to that being practically and commercially possible He believed they were very near to it. It had been said, and truly, of the electric light, as one of Dickens's characters said of the steam-engine, that it was yet in its infancy. Sometimes infants grew up well, and became a pleasure to their parents; sometimes they grew up ill; but he believed this infant would turn out a credit to its parents, and that they would soon have the electric light laid on in the manner which had been stated. The difficulties at present attendant on applying it to individual houses, were those connected with the motive power, a large question which he could not then fully go into; but there was a system, somewhat inaccurately called "storage of electricity," by which there might be brought into any house a number of boxes, not storing electricity, but each containing an apparatus which had, by the agency of electricity, been put into a condition competent to develop electricity in an absolutely regular manner, a most needful quality for the satisfactory production of the incandescent light, although he must say no want of steadiness was observable from the working of the engine that evening. You could, therefore, by the aid of these boxes, practically have electricity brought into your house, as you had gazogenes, ready charged, or as he remembered many years ago, portable gas was carted to houses in the city. Unless there weresome such system as that, persons who wanted to use the electric light had to resort to a motor of some kind, and there was the choice between steam-engines and gas-engines. A large steam-engine, at present, was more economical than a gas-engine, but on the other hand, it required a more skilled attendant. To work a gas-engine, you had to do little more than turn a tap, and to oil occasionally; the stoker and engine-driver were really at the gas works. The manager there supplied a regular flow and pressure of gas, and in that way the labour of attendance to each engine was reduced to a minimum. In the case of small engines. This non-necessity for skilled attendance reduced the cost practically far below that of a steam-engine. For that reason, he believed, that the individual lighting of houses would be done by gas-engines, and that if you took the gas with which your house was lighted, and applied it to work an engine, you would obtain a greater amount of light from incandescent lamps than by burning the gas direct. The calculation had been gone into very carefully, and were it not for the cost of replacing the lamps, it was quite clear that even now economy was considerably on the side of electricity. He was glad to hear from Mr. Johnson that in America the company preferred to include the replacement of the lamps in the fixed charge for the electricity; but that could hardly be done where each man had to produce his own electric current. A thousand hours was stated to be the average life of these lamps, some being much above and others much below the average. The other day a committee, of which he was a member, did not feel it safe to calculate the average at more than 500 hours, and then putting the cost of renewal at 5s., it turned out that that, added to the fuel, made the electric lighting rather dearer than gas, and they had deferred the consideration of the matter fo a few weeks to obtain further information. But if electricity could be laid on to houses, no doubt the problem would be, to a large extent, solved. One of the great difficulties was in the meter, but they had had one of a very ingenious and apparently efficient character exhibited that evening, and that might render practicable the establishment of a company for laying on electricity like gas or water, charging the consumer only for what he used. With regard to another point which had been considered a great difficulty—the division of the current—Mr. Preece said it was not really a divided current, but that each lamp induced its own current. That did not seem to him a very happy mode of expressing it, and he would endeavour to explain it in another way. Each of the lamps they would see, was situated between two parallel wires, from which went two small wires, which were attached to the filament of carbon in the lamp. Now, if instead of electricity they supposed water were being used, and that the wires represented the pipes, and one pipe contained a pressure of water, while the other acted as a return pipe, there being no connection between the two except by small pipes, represented by the wires going to each lamp, as long as only one of these small pipes was opened, the quantity which would pass would be only as much as could be transmitted by the one small connecting pipe; if two were opened, there would be double the quantity, and so on. Assuming for the moment that none of the pipes were open, then having once established a pressure of water, it required no energy to maintain it, if there were no leaks. You could bring the pressure up to a 100 lbs. on the square inch, and if there were no leak, it would continue for ever; but if you established a connection between the pressure pipe and the return pipe, and allowed one gallon per minute to flow away, you must exert as much energy as would supply one gallon per minute under a pressure of 100 lbs. Similarly, if you established a connection between one wire and another, which allowed a given amount of electricity to pass, you must employ as much energy as would develop electricity equal in quantity and tension to that which had passed away; if you had ten wires connected, you must develop ten times as much energy. So that it was not in truth a sub-division of the current, but was allowing the current to flow, and regulating the amount of power to be put on accordingly. It would be easy to ascertain, by an indicator at the central station, what the demands were, and determine what should be the amount of pressure, as it were, in the conductors, and the number of horse-power required to be developed in the engine, in order to supply the pressure, Mr. Johnson gave as an illustration the governor at a gas works, which controlled the pressure in the mains, and which had to be varied, from time to time, according to the draft upon them. At this time of the year, probably at half-past three, there would be a rise of pressure of so many tenths, another rise at four, again at half-past four, and so on until you got to the time when the theatres and shops were all using gas; and then came the maximum, which would be maintained until ten, when there would be a slight reduction, and a further reduction at midnight, when the uniform night pressure would come on and be maintained until about six; and then perhaps the day pressure would come on, and be maintained until the afternoon. A gas manager plotted this out on a sheet of paper which was affixed to the instrument, and this drew on the same sheet of paper, a trace showing the amounts and the durations of the pressure actually given, by the governors, so that, according to the way in which the pencil followed the lines already laid down, the manager could judge of how his directions had been carried out. Thus, by looking at the paper, you could tell if there had been a foggy day. If the day pressure provided for was say $\frac{12}{10}$, and the implement showed there had been $\frac{20}{10}$, you would know that there had been a fog, that the paper had had to be disregarded, and extra pressure put on. As he understood, provision would be made in the same way for increasing the electric current when required. With respect to the arc and incandescent lights, they would all agree that no one could dogmatise on what would be the light of the future, the whole matter being, as yet, too much in the trial stage; but, at present, he thought all would prefer the incandescent light for domestic illumination. It was admitted that the arc light was much more economical, perhaps 10 to 1; Mr. Shoolbred said 8 to 1. Then Mr. Preece objected to the arc light being placed high up; but it was shown conclusively to the committee that sat on the lighting of Liverpool, that there really was no loss by placing the light high up. It was true the effect of the light diminished with the square of the distance, and that, therefore, a light a hundred feet up would give only one-hundredth part of the intensity of light that would be given by the same light if it were ten feet up; but, assuming an equal diverging angle for the really effective rays, it would, on the other hand, light a hundred times the area. The only difference, probably, would be the want of penetrating power in case of fogs.

The vote of thanks having been passed unanimously,

Mr. **Preece**, in reply, said it appeared that his sins had been rather of omission than commission, and this would be further explained by the opening paragraphs of his paper. It must also be remembered that that was the third or fourth time he had read a paper before the Society on electric lighting, and the sixth or seventh time he had spoken on the subject, and he had not, of course, again gone over ground he had already trodden. It would not be true to entitle his paper a description of the Edison light, as other matters were treated; but it was evident that what he had said about it, and what had been seen by the audience, had produced a very deep impression on their minds.

Miscellaneous.

DOMESTIC ECONOMY CONGRESS.

Earl Spencer and Mr. Mundella received a deputation on Saturday, 10th inst., at the Education Office, consisting of Lord Norton, Sir Henry Cole, K.C.B., Mr. Holland, M.P., the Dowager Lady Stanley of Alderley, and other members of the Domestic Economy Congress. The object of the deputation was to urge upon the President and Vice-President that the knowledge and practice of home duties were at the foundation of all sound education; that the teaching of them had been much impeded by the phraseology of the codes and the use of the term "domestic economy" and its explanations; that plain English words in common use among the people, such as food, rules for health, rules for the house, and thrift, should be substituted; that these subjects should be taught practically even in infant schools; that each should receive State encouragement as a class or a specific subject; that measures should be taken through local action to secure the superintendence of the teaching of these subjects by women; and that localities should be encouraged to offer prizes and hold public local examinations annually, as was done with elementary drawing and science.

Lord **Norton**, in introducing the deputation, deprecated the use of words such as domestic economy, and supported the prayer of the memorial for more simple and common terms. He advocated the substitution of practical teaching in cookery for that now conveyed by books.

Sir H. **Cole** suggested the granting of prizes for the various subjects in the elementary schools.

Mr. **Bartley** advocated the establishment of a penny bank at all the elementary schools, suggesting that a small salary, such as £1 a-year, might be given to the teacher for conducting it. He also hoped that simple explanatory lectures might be given on the subject of practical thrift, dealing with Post-office savings banks, life insurance, deferred annuities, and the constitution and working of friendly societies.

Earl SPENCER, in reply, said that the Department was afraid of multiplying subjects and encouraging cram. As to the term "domestic economy," it was one that embraced the subjects, and he did not know that a better name had been suggested. The Department had encouraged the teaching of cookery, which had been made a second year's subject in the new syllabus for the training colleges. With regard to thrift, the Department had issued a circular to encourage the formation of penny banks, but it would be difficult to go further.

Mr. MUNDELLA agreed with what had been said as to the importance of cookery being taught practically and not from books only, and it was well worth considering whether it would not be better to separate it from the theoretical teaching of domestic economy and to make it a class subject. It was proposed by the Code to provide for systematic object lessons in infant schools, and he was glad to say that proposals were before the Department for the founding of a new college in which mistresses would be specially trained for infant schools, which were the basis of our educational system. He was glad to hear Mr. Newton Price say that the deputation did not advocate special Government grants, but he should be glad to hear how encouragement could be given without them. The suggestion that each head teacher should receive £1 a year for managing a penny bank would involve an outlay of £25,000. These forms of promoting and teaching thrift, while encouraged by the Department, would seem more legitimately to come within the scope of voluntary effort, which would do more to win the confidence of the people than the cut-and-dried machinery of a Government Department. He might mention that, at Sheffield, practical teaching of cookery and domestic arts had been so successful that, in cases of sickness and emergency, scholars were showing more aptitude and resource than their parents.

ITALIAN GEOLOGICAL SURVEY.

An account of the Geological Survey of Italy, which was established in the year 1868, has been communicated, by Mr. W. Topley, to *Nature*, and from it the following particulars are obtained. The Survey is at present a branch of the Corps of Mining Engineers. The service is partly under the control of a committee of eleven members and a secretary. Of this committee, Prof. J. Meneghini, of Pisa, is president. Seven of the members are nominated by the King, chiefly from amongst the professors at the universities. These give their services gratuitously, only the actual travelling expenses being paid by the Government. The remainder are official members, and some of them are in other ways connected with the Survey.

Each member of the committee has a certain amount of influence in the control of the Survey within his own district; he is supposed to be consulted upon all questions relating to classification, naming of fossils, &c., but the surveyors are really responsible to the official chief of the Survey, M. G. Giordano. Three members of the Scientific Committee take the chief share in the direction. These are Prof. J. Meneghini, for Tuscany and Rome; Prof. G. Gemmellaro, of Palermo, for Sicily; and Prof. J. Capellini, of Bologna, whose advice and assistance is always freely at the disposal of the Survey.

The surveying staff is part of the Corps of Inspectors of Mines (Ingegneri delle Miniere), the Chief Inspector of which is also the Chief of the Survey. Italy is divided into eight mineral districts—Turin, Milan, Vicenza, Florence, Ancona, Naples, Caltanissetta, Iglesias (Sardinia)- The Inspectors of Mines have duties very similar to those of officers holding a like position in England. They visit and report upon mines in cases of accidents; and when any important changes take place in the working of the mines, they may be called on for advice. The engineers are chosen from students trained in one of the seven engineering schools of Italy (Turin, Milan, Padua, Bologna, Pisa, Naples, Palermo). They then go for two years to a foreign mining school (Berlin, Freiberg, London, or Paris). Those engineers who are to serve on the Geological Survey Staff receive additional instruction for this purpose. Till now this extra training has generally been obtained from the Geological Survey of England, so that we may regard the Italian Survey as in a certain sense related to our own.

The basis of every geological survey must be a good topographical map. The Austrians published a map of a great part of Italy on the scale of 1 : 75,000; this however is not satisfactory. An entirely new topographical survey is now in progress; commenced in Sicily in 1862, it is gradually advancing to the north. The general map of Italy is on the scale of 1 : 50,000, with contour lines at every 10 metres. The more important mineral districts are published on the scale of 1 : 25,000, with contour lines at every 5 metres; a very beautiful map of Rome and the surrounding country is now published on the larger scale, as also are Sicily and parts of the N.W. Appennines. There is a smaller map, on the scale of 1 : 100,000, with contours at every 50 metres.

The small sum voted annually by the Italian Parliament has hitherto been spent in surveying only, and none of the maps have yet been published. They were, however, all exhibited at the Geological Congress at Bologna. It is expected that a larger grant will now be made, and the Survey be placed on a more satisfactory footing. The Central Survey office at Rome, hitherto lodged in the Piazza S. Pietro in Vincoli, will shortly be transferred to the handsome buildings lately erected for the Ministry of Agriculture, Industry, and Commerce.

The whole of the Island of Sicily has been geologically surveyed on the largest scale. This district is of commercial importance from its great yield of sulphur, amounting to 250,000 tons per year. The entire map of Sicily on the scale of 1 : 50,000 was exhibited at Bologna; this is a very beautiful work, and will be of great service to all students of that most interesting region. The Apennines, north of Pisa, are also surveyed, on the scale of 1 : 25,000. This district is of great importance, from the marble quarries of Carrara, Massa, &c., the yield of which is 150,000 tons per year. Great uncertainty has long been felt as to the geological age of the Carrara marble; it contains no fossils, and its exact relation to adjacent formations has hitherto been doubtful. It has at various times been referred to many different geological horizons; but now the geological surveyors seem definitely to have fixed its position in the Trias. The mineral districts of Sardinia and the Campagna of Rome have also been surveyed on the scale of 1 : 25,000.

The complete geological survey of a country is a work of some time, and many years must elapse before that of Italy is finished and its map published. In the meantime the Survey has done a most useful work in preparing a general geological map of Italy on the scale of 1 : 500,000. For this purpose all previously published information has been utilised; the geological notices scattered throngh various scientific journals, Italian and foreign, have been collected and arranged by M. Giordano and his colleagues. The numerous blanks have been filled up by special researches; and the result is a valuable and beautiful map, which will shortly be published. It was desired to issue a reduction of this on the scale of 1 : 1,000,000, but as no topographical map on this scale exists, a French map was adopted, engraved on the scale of 1 : 1,111,111 (or 1 decim. to a degree). This map was corrected where necessary, and was published in time for the meeting of the Congress at Bologna. The map is issued in two editions, one with hill-shading and one without. The only general map previously published was that of Collegno, in 1846, on the scale of 1 : 2,000,000, A glance at the two maps will show the immense advance which has been made in our knowledge of Italian geology since that date. Since 1870 twelve volumes of the "Bollettino del R. Comitato Geologico" have been published.

BANANA TRADE.

The last report of Mr. D. Morris, Director of the Public Gardens and Plantations in Jamaica, contains some particulars relating to the trade in bananas. The cultivation of this fruit for the American market has greatly increased, as will be seen by the following table of the exports during the last five years:—

Years.		Bunches.		Values. £	s.	d.
1880	....	440,642	....	38,556	3	6
1879	....	328,953	....	32,895	6	0
1878	....	313,145	....	31,314	10	0
1877	....	162,934	....	16,293	8	0
1876	....	132,832	....	13,283	4	0

In connection with this increased cultivation, Mr. Morris points out that some means should be adopted to utilise the vast quantity of banana stalks produced, and render the fibre they contain an article of commercial value. A trial has been made. "A quantity of stalks of the banana, split open and exposed to the sun and air for some time, and packed up in bales, were lately supplied to a firm in Kingston, for the purpose of testing the value of banana fibre for the American market. It appears, as a result of this trial, that there is an unlimited market for this useful and abundant material, and the only question is whether a large and regular quantity can be supplied for shipment monthly. As the needful preparation in the island is very simple and inexpensive, it is much to be wished that further attention may be given to this subject, in order to ensure the lucrative utilisation of a material which at present is allowed to be completely wasted."

THE SALISBURY LOOM.

The Secretary of Legation at Washington calls attention, among other inventions which have been brought to aid the development of the woollen industry, to a new loom invented recently at Providence, Rhode Island, and called the Salisbury loom, which has already received much attention from manufacturers and others interested in the textile fabric trade. A prime consideration is the cost of the machine itself, which is said to be much less than that of an ordinary loom of equal capacity. Another important feature which is claimed for the loom is that the vibratory movement given by the backward and forward motion of the shuttle in ordinary looms, so destructive to the buildings containing them, is entirely obviated. The machine stands about 5 feet in height, is cylindrical in shape; it is similar in appearance and operation to a large knitting machine, but the work it turns out is entirely different; the knitting machine for instance generally uses but one thread, and turns out a fabric capable of stretching to an almost unlimited extent, and travelling from end to end. The Salisbury loom varies in the use of four threads—two warps and two fillings—and makes an exceedingly durable and compact material of the usual elasticity given to cloth. The material may be cut in any direction or shape, leaving a perfectly raw edge that cannot be picked or unravelled. A light iron framework supports the machine proper. At the top is a cylinder, that by a peculiar device, can be enlarged in circumference or diminished according to the width of the cloth to be made. This cylinder contains 650 needles, the exact counterpart of knitting needles. The circumference of the cylinder of the machine referred to is 56 inches, producing a cloth of that width; in other words, equal to a 55-inch cloth of 650 picks, or nearly 12 picks to the inch. This cylinder contains ten knitting points, so that ten stitches are in course of construction at once; twelve revolutions are made per minute, and this rate easily produces ten yards of material per hour. The needles, in revolving with the cylinder, have an upward and downward motion given them by a series of stationary cams. If a wider cloth is required, the cylinder is enlarged by the addition of a greater number of needles, or extending the spaces between them, as may be desired. Two or three needles are omitted in one portion of the cylinder, thus leaving a break in the stitches; down this the material is afterwards cut. Another advantage which this new loom is said to have over the old ones, is that with the latter it is necessary to stop the machine every few minutes, to supply the yarn to the small spools or cops, which are quickly emptied; whereas, on the new looms, large spools are used, which run for more than half-an-hour, thereby saving time by less frequent stoppage, and the necessary labour and machinery for preparing the warp, and filling yarns for common looms. In the event of breakage of one of the threads, a very ingenious antomatic stop motion is provided; this is accomplished by short pieces of stout wire acting as weights; these are supported by the yarns in their passage from the spools to the needles. There is one weight to each thread, and in case of a thread breaking, the weight drops, and, guided by a tube, falls on a projecting lever, which being thus depressed, comes in contact with one of a series of studs placed on the revolving cylinder. On touching this stud, the movements of the machine act on a simple system of levers connected with a friction wheel, which immediately throws the motive power on to a loose pulley. The machine is checked in motion, and the power disconnected at the same moment; and it only remains to join the thread and proceed as before. Previous attempts have been made to construct looms on the same principle as the one Mr. Drummond calls attention to; the difficulty, however, hitherto has been, in dealing with the warp, which is necessary to give the material the requisite firmness. This is accomplished by using two yarns, and in the place of these two yarns lies the essential point of difference from the former attempts, and the success of the present machine.

FIRE RISKS OF ELECTRIC LIGHTING.

The following article on "Electric Lighting, its Fire Risks and their Remedies," by Prof. Henry Morton, President of the Stevens Institute of Technology, is taken from the *Sanitary Engineer* of New York.

I propose to treat this subject under two general heads, namely: 1st, The sources of danger; 2nd, The conditions of their prevention, or of security. The sources of danger in the use of the electric light are essentially two; from the conducting wires and from the electric lamps.

As long as the electric fluid or electric energy is conveyed by a sufficiently good conductor, it is perfectly harmless, resembling a river flowing in its natural channel, and powerless to rise above its banks; it is only when some easier channel into surrounding objects is offered, or some partial obstruction of a certain character impedes its regular flow, that trouble may arise. The conditions of these difficulties are, moreover, very peculiar. Thus, for example, if two electric conducting wires, forming the outgoing and returning paths of a powerful current are placed near each other, but are separated by a bad conductor, as, for example, when both are tacked on to a board partition wall, the current will follow the wire from end to end, with no development of heat in the same, or tendency to leave the conductor, or pass into any adjacent object. If, however, between the two conducting wires we introduce some imperfect conductor, such as a small wire, some metallic dust, or a film of water containing mineral matter in solution; then a portion of the current will be diverted into this "short cut" from wire to wire, and may heat the fine wire, or the metallic dust, or the wood wetted with the aqueous solution, so as to cause the ignition of inflammable matter.

Accidents of this nature have already occurred. Thus a telegraph or telephone wire having fallen across one or more of the conductors used for street-lighting purposes has been fused, or, itself escaping, has caused the fusion of finer wires connected with it. Again, two wires being the outgoing and return circuits of a powerful current, have been nailed side by side, without other insulation, on the same board of a floor, partition, or ceiling; and though used safely for a long time, while the woodwork was in its normal state, have developed a very dangerous activity, when the wood between them was wet with dirty or impure water. In that case the water offers a circuit through which a cross current is established which first heats the damp wood, then chars it, and finally establishes a series of minute arcs or electric sparks along this charred surface, which would soon develop a conflagration if left uncorrected. Again, two such wires as above, insecurely attached near each other, may be brought into momentary contact and then separated, in which case an electric arc, with its intense light and heat, will be established between them. In like manner a conducting wire itself may be insecurely connected at some point, and if the abutting ends are separated slightly during use, a similar "arc," with its intense heat, may be there developed.

These examples will give a fair idea of the dangers arising from the conducting wires, and they are manifestly to be guarded against by a proper separation and insulation of the wires themselves. Of this, however, more anon. At present, I would only further point out that there is no risk whatever of any heating or other injurious action arising in or from the conductor itself when an adequate one is used, as must be the case from motives of economy; since an inadequate conductor would involve ruinous expense in the use of the electric current.

Electricity is not to be regarded as a sort of fluid fire passing along the conductor; and some popular notions on this head are as absurd as were similar ones which prevailed in reference to illuminating gas, at the time of its first introduction, and which caused rules to be made in some places, that no gas pipe should be allowed to come in contact with any woodwork.

Turning next to the dangers which might be expected from the electric lamp, it is to be remarked in the first place, that these, in the case of the arc lights, depend much upon the number of lamps operated on the same circuit. Thus if thirty or forty lamps are operated in series, the electromotive force of the current must be sufficient to maintain a corresponding number of arcs; and, therefore, if by any means many of these arcs are closed out, the electromotive force of the current available for the remaining ones would be so excessive, that their arcs might become excessively long, and even the metallic carbon holders and other parts of the lamps constitute poles between which the arc would spring, melting the metal work, and establishing a very dangerous centre of combustion.

To avoid this class of dangers, two provisions should be made. In the first place, some arrangement in the lamp itself by which, whenever the arc exceeds certain safe limits, the current will be automatically diverted from it, and carried through a good and sufficient conductor; and, in the second place, some apparatus, in connection with the electric-generating machine, by which the electromotive force of its current should be varied automatically in correspondence with the resistance of the circuit, so that any diminution of such resistance, as by the closing out of several arcs, should cause a corresponding diminution in the force of the current generated. Numerous contrivances for both of these purposes have been already carried to greater or less perfection and efficiency, and it is manifestly possible by such means to secure immunity from risks of this sort. The securing of adequate insulation for the conducting wires, in view of the endless ramifications of telegraphic and telephonic systems, to say nothing of the other conductors found in all buildings, is a problem of no small difficulty. One important general principle would seem to be the equal insulation of the return as well as of the outgoing wires, as well as of the machines, and the avoidance of all ground connection for any part of the circuit. Another general rule would be the separation of outgoing and return wires as far as possible from each other; and yet another, the continuous insulation of conductors leaving no vulnerable places even where danger would not directly result from accidental contact. Fully to discuss all the details of this subject would be impossible within the proper limits of such a note as the present, and I will therefore only say in conclusion that, with well matured plans and skilful and intelligent provision, all these dangers may be provided against, and electric lighting may be made as safe as that obtained by gas or by candles; but without such care and judgment, the use of electricity on the grand scale, either for lighting or for transmission of power, would involve serious additions to the risks which accompany so many of the conveniences which constitute a large factor of our modern civilisation.

Obituary.

Sir Antonio Brady, who died suddenly on Monday last, 12th inst., had been a member of the Society of Arts for more than thirty years. He was a constant attendant at the meetings, and took the chair on several occasions. He was greatly interested in all attempts to improve the Patent-law, and at the last meeting of the British Association at York, he spoke in favour of the Society of Arts' Patent Bill. He was greatly instrumental in the foundation of the Bethnal-green Museum, on the establishment of which (in 1872) a congratulatory dinner was given in his honour. Sir Antonio Brady was the eldest son of the late Mr. Antony Brady, of the Royal William Victualling-yard, Plymouth, by Marianne, daughter of the late Francis Perigal, and was born in 1811. He entered the civil service of the Navy as junior clerk in the Vitualling-yard, Deptford, and having served there and at Plymouth and Portsmouth, was promoted to head-quarters, at Somerset-house, and in 1854 became head of the contract office and registrar of public securities. He subsequently assisted in the re-organisation of that office, and was the first superintendent of the new purchase and contract department. He retired from the service in 1870, when he was knighted, and henceforth gave up his time and talents in the promotion of social, educational, and religious reforms. He was Judge in the Court of the Verderers for the Forest of Epping, which he was greatly instrumental in preserving for the public use, and was fellow of several scientific societies. He was prominent among the promoters of the Smoke Abatement Exhibition, now being held at South Kensington, and had arranged to read a paper this week at the Brighton Health Congress.

General Notes.

Replanted Trees.—During the hurricane of October 14 last an immense number of noble trees were uprooted. In several places successful attempts have been made to replant some of these. Two instances are reported in the *Gardeners' Chronicle*. One of these was at Highfield, on the Duke of Wellington's estate of Strathfieldsaye, where trees of ten to twelve feet in girth were successfully replanted, and the other at Dunse Castle, Berwickshire, where a dozen of the trees which formed a grand lime-tree avenue have been replaced in their old position, and now stand firm and erect.

NAVAL ENGINEERING EXHIBITION.—A Naval and Submarine Engineering Exhibition is announced to be held at the Agricultural-hall, in April, 1882. A prize of one hundred guineas is offered for the best means of saving life in cases of shipwreck at sea, and a second prize of fifty guineas "for the best invention of a humane character connected with seafaring."

FIJI ISLANDS.—Mr. H. H. Hayter, the Government Statist of Victoria, has added to his report of Australian statistics for 1880, the statistics of the Fiji Islands for the years 1878, 1879, and 1880. The total estimated population on the 31st December, 1880, was 121,884; the public revenue, £80,678; the public expenditure, £91,102; and the public debt, £210,000. The value of imports, £185,741, of exports, £229,528. Of land under crop, there are 1,683 acres of maize, producing 38,039 bushels; 5,176 acres of cotton, producing 774 tons; 1,529 acres of coffee, 2,160 acres of sugar cane, and 16,350 of cocoanuts. The number of horses are given as 360; of cattle, 5,000; of sheep, 4,769; of pigs, 50,000.

CENSUS OF VICTORIA.—The results of the census of Victoria, taken on the 3rd April of the present year, have been issued by Mr. H. H. Hayter, the Government Statist, from which it appears that the area in square miles is 87,884, the total population 862,346 (452,083 males, 410,263 females), the inhabited dwellings 170,086. The totals in 1871 were—Population 731,528 persons (401,050 males, 330,478 females), inhabited dwellings 150,618. The most marked feature of this comparison is the increase of females by 79,785, the males having only increased 51,033 during the same period.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock.

The meetings after Christmas will commence on January 11th, 1882, and the arrangements will be announced in a future number of the *Journal.*

INDIAN SECTION.

The Meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 17; March 17, 31; April 21; May 12, 26.

An additional meeting will be arranged for the end of January, when Sir Rutherford Alcock, K.C.B., will read a paper on the "Opium Trade." The date will be announced later.

FOREIGN AND COLONIAL SECTION.

The Meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 31; February 28; March 21; April 4, 25; May 23.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The Meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 26; February 23; March 9, 23; April 27; May 11.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 19...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the Paper by Mr. E. P. Squarey, "Land Legislation and Tenants' Improvements;" and on the Paper by Mr. P. D. Tuckett, "The Cause of the Failure of the Agricultural Holdings Act of 1875, and the Present Agitation for Protection for Tenants' Capital."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Hugh Stannus, "The Artistic Treatment of Constructional Ironwork."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 3 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. Aitchison, "Colour as Applied to Architecture."

TUESDAY, DEC. 20...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Annual General Meeting.

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. G. Phillips Bevan, "The Industrial Resources of Ireland."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

WEDNESDAY, DEC. 21...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Prof. John Eliot, "The Rainfall of Cherrapunji, Assam." 2. Dr. Marcet, "On the Meteorology of Cannes, France." 3. Commander R. A. Edwin, "The Principle of New Zealand Weather Forecasts." 4. Rev. T. A. Preston, "Report on the Phenological Observations for 1881."

Geological, Burlington-house, W., 8 p.m.

THURSDAY, DEC. 22...Royal, Burlington-house, W., 4½ p.m. 1. Mr. W. Heape, "The Germinal Layers and Early Development of the Mole." 2. Dr. E. J. Mills, "Melting Point." 3. Dr. W. H. Gaskell, "The Rhythm of the Heart of the Frog, and on the Nature of the Action of the Vagus Nerve." 4. Mr. A. R. Forsyth, "Memoir of the Theta-functions, particularly those of Two Variables." 5. Mr. W. H. L. Russell, "Certain Geometrical Forms." (I.)

London Institution, Finsbury-circus, E.C., 7 p.m. Rev. H. R. Haweis, "Mark Twain."

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FRIDAY, DECEMBER 23, 1881.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

All the tickets for Mr. Preece's Lectures on the "Recent Wonders of Electricity," having now been disposed of, the issue has been stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

The Secretary will feel greatly obliged if any member, who is unable to use his ticket, will kindly send it back.

PRACTICAL EXAMINATION IN VOCAL & INSTRUMENTAL MUSIC.

The next Examination in London will be held at the Society's House during the week commencing 9th of January, 1882. Examiner, John Hullah, LL.D.; assistant examiner, W. A. Barrett, Mus. Bac. Oxon. Particulars will be forwarded on application to the Secretary, Society of Arts, John-street, Adelphi. No names can be received after the 27th December, 1881.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

In connexion with the course of Cantor Lectures, which will be delivered by Captain Abney, F.R.S., on "Recent Advances in Photography," in January and February next, it is proposed to hold, in the House of the Society of Arts, an Exhibition of Photographic Appliances.

The dates of Captain Abney's Lectures are January 30th, February 6th, 13th, and 20th. The Exhibition will be kept open from January 30th till about the end of February.

The Exhibition will be of a technical character, and it is not, therefore, desired to collect photographs of artistic merit only.

The following are among the principal classes of objects sought for exhibition:—

Apparatus; cameras, lenses, tents, instantaneous shutters, slides, sensitometers, lamps (intended specially for photographic purposes), enlarging apparatus, printing and mounting apparatus, &c.

Photographic materials.

Illustrations of new processes; negatives and prints produced by new or special processes.

Appliances used in reproductive processes; specimens of illustrations produced by such processes; specimens of historical interest, as illustrations of old processes.

Lighting; models illustrative of characteristic features in the construction of glass houses; methods of fixing glass without putty or similar material; arrangements for the production of artificial light for photographic purposes; apparatus illustrating applications of photography to scientific purposes.

Any person wishing to exhibit any of the above is requested to communicate with the Secretary of the Society, who will supply printed forms of application for space, and will be glad to give any further information required.

Arrangements are being made for showing the actual working of some of the more recent processes.

Proceedings of the Society.

PATENT-LAW AMENDMENT BILL.

The discussion on this Bill was resumed on Thursday evening, the 15th inst.; Sir Frederick Bramwell, F.R.S., in the chair.

The Chairman, before commencing the discussion, alluded to the loss the Society had recently sustained in the death of Sir Antonio Brady, a gentleman who had devoted many years of his life to the subject now under discussion. Shortly before his death, he wrote a letter to the Secretary on this very question, and he thought it would be well to have that letter read. He might add that, although the Committee had duly considered the opinions expressed at the previous meeting by the different speakers, and especially those delivered by the Chairman, they thought it better to refrain from any expression of their own views until they had heard the further arguments which were to be adduced on one side or the other; therefore, beyond saying that the observations which were then made had not been lost sight of, he did not propose at present to state how far the opinion of the Committee had been modified by those already expressed.

The SECRETARY then read the following letter from Sir Antonio Brady:—

Maryland Point, Dec. 2, 1881.

MY DEAR SIR,—I regret that a severe cold will prevent my being present at the meeting to-night. I dare not face a crowded meeting and the night air after. I am very anxious to express my opinion on the Patent Bill as prepared by the Society of Arts. It is the best Bill that I have seen, and its details have been most carefully considered; and if passed into a law, would, I consider, be a great blessing to inventors, and conduce to the best interests of the country, and tend to promote the inventive genius of the people. The more I think of it, the more I am satisfied that the remarks I made at the meeting of the British Association at York, in the autumn, in seconding a vote of thanks to Sir F. Bramwell, your Chairman of Council, for his admirable address, were well founded. The only fault I then found in the Bill, was, that the fees were too high, and in the interest of poor inventors, I entreat the Society of Arts to re-consider this part of their Bill. The fees I consider excessive, and so does the Inventors' Institute (of which I have the honour to be President, in succession to the late Sir David Brewster and to the Duke of Westminster). The fees, we think, should only be sufficient to pay the cost of an *efficient Patent-office;* and not be used for any purpose of revenue, on the ground that it is not politic to tax the inventive genius of the country, which should be fostered in every possible way. I hear that the Americans even think that their very moderate fees are too high, and that they contemplate a reduction. As I am unable to be present personally to state my opinion, I trust the Chairman will kindly allow this letter to be read.—I have the honour to be, my dear Sir, your most obedient Servant,

ANTONIO BRADY,
President Inventors' Institute.

H. Trueman Wood, Esq.,
Secretary Society of Arts.

Mr. HENRY W. LEY said he desired to rescue the discussion from what he might call the professional element. On the previous occasion there were only two lay speakers, and out of the report of the discussion of some 25 columns, they only came in for about 1½. But he ventured to say, that in a discussion of this kind, it was just the lay speakers who were wanted, and that the fitting arena for professional and technical opinion was not so much the public hall as the private committee-room. The subject of fees was not commented upon at all by professionals; they simply passed it by on the other side, and naturally enough, seeing that it was not before, but only with the payment of fees that their work began. But with the lay speakers the importance of fees came to the front, for the first remark of the first speaker on the previous occasion referred to this point. More than one speaker on the first occasion thanked the committee for their labours, but he could not do so, for this reason. He was a patentee and a poor man, and a would-be further patentee, and he asked what genuine word of relief there was in that Bill for the large class of inventors who were of scanty means. Examining the evidence taken before the Patent Committee, he found there all interests represented except the interests of the poor inventor; and on looking to the constitution of the Committee who prepared this Bill, again he had to ask where was the poor man's representative? To the poor inventor, who for years had been looking for patent reform, this Bill brought no aid, and he must ask its advocates to explain what, so far as this class of inventors was concerned, was the logical difference between their position and that of those who would abolish patents altogether. For those who would abolish patents entirely, he had some sort of respect; their stand-point was, at any rate, a definite one, and they, at any rate, treated inventors alike all round; but what possible sympathy could he have with those who would abolish patents unequally —that is, abolish them for all except themselves, in fact, for all who could not pay the fees they could pay, and who would keep patents as they now were—class privileges. He said abolish, because just as you took a man's life if you took his means of living, so you abolished a man's patent if you made it dependent on conditions which he was quite unable to fulfil. Sir Frederick Bramwell, on the first night, said he hoped the discussion would not go into the rights of inventors. Into their abstract rights there was no need to go, because it was to be taken as conceded that there should be a Patent Bill. The relative rights of inventors was, however, a very different matter. It was, indeed, the all-important matter, and those must be gone into. To concede a Patent Bill was to concede that an invention should be a property; but having got so far, the Bill jumped the intermediate step between the invention and the patent, and made property, not of the invention but of the patent. In the second sentence of the preamble, the framers of the Bill said that the existing law did not sufficiently secure property in an invention to the true inventor. But the existing law did not secure property to an inventor as inventor at all, but only as patentee; the existing law was respecter of persons and gave property in inventions only to those who could pay its scheduled fees. If it was replied that for the existing law not to protect inventors as such at all was, to "not sufficiently" protect them, then he said that was not the meaning of the Bill, for this Bill was no less a respecter of persons than the existing Act, and cared no more for the inventor as such than that did. Sir Frederick Bramwell said the interest of the public and the inventor was one and the same interest if properly understood; if so, it was very evident that the framers of this Bill did not properly understand it, and Sir Frederick Bramwell, who said, and very truly, that reiteration was needed to get a truth into the public mind, would have to reiterate this truth about the interest of inventors and the public being the same interest, in order to get it into the minds of the framers of the Bill, because the moment the framers came to the Bill it was the interest of the public on one side, and not of inventors generally on the other side, but only of those inventors who, to use a shop phrase, could pay their footing. Sir Frederick Bramwell said that in framing the Bill this principle had been borne in mind, that "so far from its being a bar to the development or improvement of an industry that an invention to which an improvement related should be in the hands of an owner, it was absolutely the only means by which an invention could be introduced." Borne in mind? Why the framers of the Bill forgot it as soon as it was conceived; for they gave to the actual parent of an invention no property whatever, unless he could give what might be called a fictitious certificate of respectability. To thousands of men like this £12 10s. never came, and a five pound note was a fortune, and if the necessary amount were out of reach, it mattered not to what degree. No doubt £12 10s. was a trifle to the framers of the Bill, but he would say to those who regarded that sum lightly, that they had never really known what the want of money meant. Why should not patents be free, seeing that they were paid for by the very condition of their grant? Because an inventor put the public on a level with himself in knowledge, a certain monopoly was granted to him; he paid for his patent by the equality of knowledge he conferred on the public. How little the framers of the Bill cared for the inventor as such was shown by the Bill itself. The essential condition of protecting an invention, must be necessarily to ascertain what it was. The inventor told the public something useful, and in return was allowed the monopoly of using it for a certain time; and under the existing law, the particularly describing and ascertaining the nature of an invention was the "express condition" of the grant; but in the present Bill, this all-important express condition was entirely omitted, but the provisions for the payment of fees were most carefully retained. He thought if the public lost those it lost nothing; but if it lost the description of the invention, it lost what it wanted, and what it bargained for. The advocacy of free patents was not a "no-rent" manifesto; if pecuniary fees were to be paid, let them take the form of a tax on success, not the form of taxation on a castle in the air, for that was what an invention really was, until it was brought into commerce. What was to be feared in making patents free? Bogus applications? Such a thing was a fraud, and should be punishable as such. Besides, there was a set of examiners in this Bill who could detect and reject such applications, and if they did not, it would be very strong evidence that an application was not bogus. Were trivial patents to be feared? What was a trivial patent? In the majority of instances he believed the definition to be this:—A trivial patent is one which has already been granted to somebody else for an idea which now occurs to me. Writing to him on on the subject of patents, a friend said that only those inventions should be patentable which required time and expenditure to perfect; but the great invention of James Watt would not have been patentable under such conditions; it was one which required neither time nor expenditure; it was perfect the moment it was conceived, and required no experiment for verification; and yet such an invention, which revolutionised the steam-engine, would not, under such a rule, have been the subject of a patent. To the poor inventor, the matter of fees was all important. It was said they should agitate. Why should they need to agitate for equal justice? Even upon the ground of expediency, to which Sir Frederick Bramwell desired to confine the discussion, what was justice but the highest expediency? They ought no more to have to agitate for justice than a child for education from the parent. To supply the child with food, clothing, and education was the duty of the parent; and it was the duty of the State to mete out equal justice to the poor inventor, without the need of asking for it. To those who spoke so comfortably of agitation, he should like to give two years of an ordinary workman's lot, so that they might know what it was to be at work at six o'clock in the morning, day after day, month after month, and year after year, light or dark, fair or foul, well or weary; after two years of such a life, they would know what it meant, and what agitation meant to those whose whole normal existence was as he had pictured. Why should they agitate? He read in the preamble that it was highly important that new and meritorious inventions should, for the good of the arts and commerce of the realm, receive all possible assistance and encouragement, but the preamble was quite ignored in the Bill itself.

Dr. C. W. SIEMENS, F.R.S., said, on listening to the discussion, he had been reminded of a fable of antiquity which he had learnt in his youth, to the effect that Jupiter, at one time when there were a few people in the world, thought that as he had heard a good deal of grumbling about the weather, he would give them the option of fixing their own weather; and, accordingly all the craftsmen met together, the agriculturist, the grazier, the miller, and the potter, in order to debate what weather would suit them best. He need hardly say what was the result of the meeting—they all thoroughly disagreed. The potter thought it was outrageous to have a shower nearly every day, which suited the grazier; the grazier thought a long drought, such as the agriculturist required, was most detrimental to him; and the miller thought unless he had a deluge of rain every week, his water-power could not be kept up. The case before them was almost parallel to that of his fable. The Committee had undertaken to frame a Bill which should be agreeable to the lawyers, to the patent agent, to the inventor, both rich and poor, and to the consumer, the public at large. At the previous meeting they heard how the representatives of the High Court of Law found they had trespassed on their prerogative. They thought law without the High Court of Justice would be an abortion, because there could be no compensating claims, such as breach of promise of marriage, brought into a Patent-law suit, and that would be a great pity. Probably the Bill required some amendment as regarded legal procedure, but what was wanted in the patent interest was cheap justice; a law which did not take up inventors' time for years and years in contending patents, which might probably be of interest to lawyers, but which prevented patentees from following the peaceful mission which it was their province to pursue. Passing from the purely legal question, to that of administration, he came to the objections brought forward by a very eminent patent agent, who no doubt, being very confident of his own skill and power to advise his client, rather disparaged the interference of a body of examiners and Commissioners. Well, what was the object of these examiners? They might be used for putting down such inventions as, according to the arbitrary mind of the examiners, were not worthy of a patent; but a careful examination of the draft Bill would show those interested that this point had been properly guarded against, that the examination of the application would act rather as a protection for the applicant than to his detriment. He knew from his own experience, and probably many would agree with him, that sometimes one lodged the provisional specification, and, notwithstanding all care on the part of the patent agent, some specification or some publication turned up to interfere with it. It was not the applicant's intention naturally to repeat an old thing, but his ignorance of what had been done before made him spend his time and money needlessly. He thought it a matter of great importance that intending patentees should have, for the fees paid, good and trustworthy information, such as the Patent-office alone could furnish, by means of official examiners. There were large funds in the Patent-office, which, instead of accumulating farther, should be utilised for the benefit of patentees. One of the most essential things was, that it should be clearly pointed out what had been patented and published, in order that the inventor might see whether he had made a mistake, or whether his application required to be modified, in order that it might have a good patent. At present it was simply to pay your money, and take your certificate. If you paid your fee you got your grant; and if the Patent-office had taken the same fee for precisely the same invention the day before, who cared. The second man lost his money, and the Treasury gained. He thought the most valuable part of the present scheme was, that the examination should not be carried on to the extent to which it used to be carried in Germany, and to which it was perhaps carried still in the United States, but that there should be such an examination as would aid the applicant to a true perception of his position. They had heard some very strong observations against the Bill on the part of the poor inventor, and he (Dr. Siemens) felt disposed to go some length with what Mr. Ley had said, only it would be impossible to carry a measure involving a very large reduction of fees. The fee to be paid by the inventor, in the first place, should certainly not be more than any careful working man could afford to pay, but after having obtained his grant, the question was, how were they to discern whether a patent was a workable patent, and whether the inventor did apply himself to the introduction of it or not? In France, and in some other countries, the law stepped in, and required the patentee to bring some proof after the lapse of one or two years that the invention had been practically introduced, but that provision was very objectionable. If you invented a mouse-trap, you could put it into use within a week; but if you invented a process, it would take some years before you could possibly expect any practical result. The previous speaker instanced the case of James Watt as one where an invention came perfect into the world; but he would ask him how it was that Watt spent seven years before he could obtain any practical results, and how it was that he first, in combination with Dr. Roebuck, came to the point that he would have had to abandon his patent if he had not been taken up by Boulton, who thus enabled him to give his invention the development which made it the foundation of a great advancement in civilisation. The invention by Watt of the separate condenser and air-pump was just one of those which required a great deal of knowlege and mechanical skill in order to develop its merit, and such must be the case in every instance where any important change was contemplated. Then he came to the last class of interested parties who, so far, had not been represented in the discussion—the user; and, although he himself belonged to the class of inventors, he thought the user had, after all, the first right to be considered. In connection with this point, he thought a little anecdote which he heard with regard to a Minister of State under Louis XV. was appropriate. Pensions had been granted to poets, and poetry was a very good thing, of course; then a poet came to him claiming a pension, but the Minister declined to grant it. Well, said the poet, "*Il faut que je vive.*" "*Je n'en vois pas la necessité,*" replied the Minister, politely shrugging his shoulders. If the public could do without inventions, they surely would have the right to say, we will not have any inventors. If they could do without them, and could be happy without them, they had a perfect right to say, we will not have patents. But nearly all thinking men now were agreed that they could not get on without patented inventions. The cry of "No patents" had died away, because it was founded on error, and they had now to consider what was the best form of grant to give to an intending patentee, not for his own aggrandisement, but for the public advancement. If they kept the public interest involved in the question chiefly in view, they would be much more likely to arrive at a fair and reasonable conclusion than if they started with the idea of an indefeasible right in the inventor. After all, Letters Patent were not property, in the sense of real estate. Real property was absolute, and was not taken away after a term of fourteen or fifteen years. But no country had ever proposed, and no inventor had ever asserted, the right to a perpetual monopoly in his invention. The granting of a patent was a temporary endowment, in order that the patentee might have, first, time to develop the invention, which was the important thing as far as the public were concerned, and in doing so have the opportunity of earning a proper compensation for the expenditure of ingenuity, time, and money which he had made. The duration of a patent should be sufficient to enable a patentee to earn a fair remuneration; and as regards this term, the Bill proposed to substitute seventeen for fourteen years, a period which he thought would generally satisfy the justice of the case; but in case of exceptional circumstances, there would still be power to grant extension. Another important point in the Bill was that the Government would be bound by patents. At present it was a crying evil that Government departments stood above patents; and, speaking from his own experience, he could prove that, so far from this benefiting Government departments, they were left to their own resources, and, instead of applying an invention properly, they were likely to apply it improperly, simply because they had not the guidance and advice of the patentee. There was no reason why a public department should not be liable to remunerate an inventor as much as any of her Majesty's subjects, provided the claims made upon them were not unreasonable ones. This latter consideration brought him to another provision of the Bill, which he would urge very much on the inventor class, viz, that for compulsory licenses. This had not an agreeable sound in the ears of many inventors, who maintained that their invention was their property, and they should have liberty to deal with it just as they thought proper. But he could not admit that doctrine of absolute property. A patent was a trust, the inventor was made the guardian of the invention in order that he might bring it into public use. If he should assume the position of the dog in the manger, the law ought to step in and say, "No, that is not the bargain; it is for public use, and for the public benefit, that the grant has been made." There were many inventions which could be carried out quite well by the inventor himself, as, for instance, if it were a new machine for a special purpose, such as a meter, the patentee or his friends might erect works to supply the public, and there would be no necessity for compulsory licenses; but if it were a process which applied to an important industry, such as the iron or steel industry, or to spinning, it would be a public injustice if the inventor were to say, "I will empower this one factory, only to carry out this invention, to the detriment of the whole country." It was only just that under such circumstances the law should step in and arbitrate between the parties concerned. Such arbitration would, he believed, greatly benefit inventors as a class. Speaking for himself, he had often been a great deal pressed by intending licensees to grant them exclusive licenses, and if not for the whole country, at any rate for a county, but he had always set his face against it, because it would be sure to bring him to a place to which he had an insuperable objection, viz., the Law Courts. He had, therefore, always refused to grant exclusive licenses, and if there were such a clause as that under certain circumstances the inventor would be obliged to grant licenses, he would have a capital answer to give to the would-be monopolists. In conclusion, he would say that objections were naturally raised against the provisions of the Bill by the several interests he had alluded to; but in discussing this question, he would submit that it should be looked upon from the point of view of making the law acceptable all round, and for the greatest benefit to the public at large.

Mr. Hugh Clements agreed to a great extent with the first speaker, that the framers of the Bill had not taken sufficiently into account the circumstances of working men, who, no doubt, made most of the inventions, though very often men of wealth carried those inventions through. The Bill laid great stress on the true inventor, but he did not think there were provisions for getting at the true inventor at all. Even under the present system it would be quite possible to provide for patents being taken out much cheaper than they were at present. The annual expenses of the Patent-office only amounted to £25,000, whilst it received in fees £100,000, so that there was a saving of £75,000 a year. He thought it would be only necessary to pay a quarter of the fees now charged, and did not see why there should be a tax on the inventive genius of the country; besides, the more the fees were reduced, the larger, in all probability, would be the income obtained. The last speaker said that inventions should be encouraged, but the existing law did everything possible to discourage inventions. In other countries, patentees were more encouraged; for instance, in the United States you could take out a patent much cheaper, and the consequence was, London was flooded with cheap patented inventions from America. There could be no doubt that working men were most likely to produce new inventions, and he did not think the higher and middle classes made more than one per cent. of the total. The Bill was an improvement on the present Act, because it reduced the fees to about half, but if it were put before the working men of the country, he thought the expense would be reduced to £2 or £2 10s. Those who drew up the Bill probably thought no more of £2 10s. than a working man did of sixpence, and he thought it was a great deal the fault of working men themselves as they had not agitated for a better Patent Bill. The present system was a disgrace to society generally, and he did not see why there should be any litigation at all. The granting of a patent ought to secure the patentee against any legal expenses. With regard to the Commissioners, it was proposed that there should be an engineer, a chemist, and a lawyer; but what did engineers and chemists know of the five or six groups of subjects brought before the Patent-office? He thought they could not do better than improve the present Patent-office, and if there were law cases they should be tried by a lawyer, assisted by experts.

Colonel HOPE, V.C., desired to bring forward one point which had been partially touched upon by Dr. Siemens, viz., the position of inventors in respect to the Government, it being unfortunately a point which he knew something of from personal experience. Of course, if an invention specially connected with the army or navy was made, the Government necessarily must have the right of taking and using that invention if desired, because the safety of the country at a given moment might almost depend upon it; but at present the Government claimed the right of taking the invention, and either paying nothing at all for it, or merely whatever crumbs or bones they might please to throw at the inventor's head. That was a position which was degrading to the inventor. If you were rash enough to write to the War-office and offer them an invention, they sent you a printed paper, one of the regulations of which was that you must make a clean breast of your invention, or they would not entertain it. But the persons you had to submit the invention to were rival manufacturers and inventors. That was a position which was absolutely grotesque, and certainly the compulsory license system alluded to would meet the case. If he had inherited an acre of land which a wicked ancestor of his several generations ago had stolen from the Church, and if the War-office required the acre on which to erect fortifications, they could take it compulsorily, and very properly so, but he would be paid for it at its market value. In that respect he differed from Dr. Siemens; he thought an invention was even more the property of an inventor than an acre of land he had inherited from his wicked ancestors. If he chose to bottle it up in his brains it remained his property, was buried with him, and might never be rediscovered or re-invented. If, therefore, he took out a patent, it should still remain his property, subject always to those reasonable conditions, such as compulsory licenses, which would give the public the benefit of it on fair terms. The position of inventors towards the Government was one of very considerable importance, and he was glad to hear from Sir Frederick Bramwell that it was now pretty generally recognised, but the absolute necessity of protecting inventors from the Government, just as much as protecting the Government from inventors, could not be too often impressed both on the Government and on the public.

The CHAIRMAN said this principle had been recognised in the last two Government Bills which had been brought in.

Mr. CLEMENT HIGGINS, having listened with great care and attention to all which had been said thus far, thought there was a consensus of opinion in favour of the principles involved and endeavoured to be carried out in the first part of the Bill. That being so, he would not take up time by enforcing the truth of those principles or the necessity of carrying them out, but would endeavour to serve the ends of the Bill, and assist the Committee by calling attention to one or two particulars in the first part, which seemed to him might be improved. He referred especially to the third paragraph of the third section, first to that portion of it between the fifth and tenth lines. That provided that an invention was deemed new if it were not published or publicly used in this kingdom within 30 years immediately preceding the application for a patent for that invention. That was, to all persons familiar with the Patent-law of this country, rather a startling proposition. He did not say it was on that ground bad; and it did, in his opinion, contain one very valuable feature, which was this, and which was its justification as put forward by Sir Frederick Bramwell, that it prevented a valuable invention being held invalid simply because of some ancient and incomplete description of it. If it went no further than that he would support it, but he ventured to submit that it did go further, and the words of the section went further than they need do. He went so far as to say that a patent should not be invalided by a description of the invention or even by public user. Now, he would suggest that no monopoly should be given for a manufacture which had once been used in the United Kingdom. The object of a patent was to reward inventors, but not necessarily to reward those who happened to re-introduce a manufacture which was once publicly known, and he would, therefore, suggest some alteration in those words. There was another important point. The words of this section seemed to fix too hard and fast a line. There surely ought to be some discretion left to the Commissioners to regulate the length of time during which the thing should be known, in order to invalidate a patent for it, bearing in mind the character and nature of the invention itself. He thought the wording of the section might be improved, so as to give it a little more elasticity. Lines ten to fifteen were also startling. They provided that no publication should affect the validity of the patent unless it contained as full and ample a description, and the means of carrying the same into effect as would be required from the patentee, in the specification of a patent for such invention. It was difficult indeed, to reason on the section, because they did not know what would be required by the proposed Commissioners from the patentee in his specification. If the new Commissioners were to construe specifications in the same way that they had hitherto been construed, he should agree with the clause, because, as the law now stood, a specification must contain such a description as would enable a skilled workman to carry the invention into practice. If the prior publication of an invention was of such a character, it ought to invalidate any patent granted for that invention, but nothing short of such a description ought to be sufficient.

The CHAIRMAN said that was entirely the desire of the Committee, and if they had failed to express it in words, he should be glad if Mr. Higgins would supply them with an amended clause.

Mr. HIGGINS said he would now proceed to the 5th clause of the Bill, which he ventured to say, was wholly bad. It proposed to define what a patent might be granted for; and with regard to this part of the Bill there were many fatal objections to be taken. In the first place, a great deal of time and money had been spent in ascertaining what the subject-matter of a patent was, and if these definitions were enacted, the whole of that time and money would have been expended in vain. They must begin again, and get other decisions on all these different cases as to what inventions might be patented. More than that, he thought it was unnecessary to attempt to define what a patent could be granted for, because it was satisfactorily defined as being a "new manufacture." With regard to the subject-matter of patents, there was probably no part of the Patent-law which was better and simpler, and gave rise to less litigation, because, as a matter of practice, the objections taken to subject-matter practically came to this—Is it a new manufacture? If you once grant that an invention is new, you may be pretty sure it is patentable, unless it were the discovery of a new scientific principle, and that, he assumed, not even the most ardent admirer of the Patent-law would wish to monopolise. Passing on to the 17th clause, which related to the opposition to the granting of a patent, the only suggestion he wished to make was that it should not be confined to the one ground named, which was that the applicant had obtained the invention from the person opposing. He thought the grounds of opposition should include anything in the nature of fraud by the applicant; and, if it were proved, it ought to be a sufficient reason for refusing the patent. There, again, he thought it would be desirable to retain that ground which was now allowed, that the person opposing had invented the same thing, and then it was very easy to make a compromise between two inventors when they might be each entitled to a patent, and so again, in cases of prior user. If a person was in a position to prove a case of prior user, he ought to be allowed to oppose. When he came there that evening, he anticipated that the second part of the Bill would be wholly withdrawn, after having heard the onslaught which was made upon it by Sir James Stephen; but as it still remained, he was entitled to say something about it.

The CHAIRMAN said all Mr. Higgins's observations, so far, were adverse to the 1st Part of the Bill, but there were many other sections in that Part which differed materially from previous Bills, and he should be glad to know whether these sections had Mr. Higgins's assent or not.

Mr. HIGGINS said that he agreed entirely with the principles of the first part, and the way in which those principles had been carried out, in all except those points he had mentioned, with one exception, to which he would call attention presently. With regard to the second part of the Bill, which proposed to constitute a new Court for the trial of patent cases, if he could satisfy the meeting that the High Court of Justice, as it was at present constituted, was better fitted to try patent actions—he did not mean better for lawyers, but better for the patentee and the public, than the proposed Court of Commissioners—then there was no case made out for altering the law. In doing that he had the right to assume that they had in that Bill the best kind of Court which was capable of being constituted, of a non-legal character. He had the right to assume that the Committee who were able to produce a Bill so good, so clear, and so thoroughly consistent as the first part of the Bill, were as fully able to constitute a non-legal Court as any Committee which could be obtained, and therefore he should treat this as being the best non-legal Court possible; and in order to show what that was, he would show what would be some of the results of its working. In the first place, you would have many actions involving the same questions as arose in an action for the infringement of a patent still being tried in the High Court. In the first clause of the second part of the Bill the framers had not ventured to include actions on licenses taken for working patents. Suppose a man took a license for a patent, and made something very like the patented invention, and the patentee said, "I shall sue you because you are not paying me on this license, but you are making something which is practically an infringement." This new Court could not try such an action. Then suppose you had an action brought for goods sold and delivered, to be made according to a certain patented invention, and the defence was that they were not made according to the invention, you would have the scientific questions, if any, which would be involved in an action for infringement, equally involved in that action. There would be many cases, which he would not attempt to enumerate, and especially as they were dealt with so fully by the Chairman on the first occasion. You might have an action brought for the infringement of a patent, and the defendant setting up a counter-claim; in that case the defendant would be excluded from his right of bringing his counter-claim, or set-off, against the patentee. Again, if this Court were constituted, you would have patent actions of two kinds. First of all, the ordinary patent action, brought in the Commissioners' Court, for the infringement of a patent which had been favourably reported on by the Examiner; but if you brought an action for the infringement of a patent which had been adversely reported upon—

an endorsed patent—the patentee would have to go to the High Court. An action on a patent, *primâ facie* good, would be tried by the Commissioners; but an action on a patent, *primâ facie* bad, would be tried in the High Court; but he supposed Sir Frederick Bramwell would say it did not matter what became of a patent which was *primâ facie* bad—and, therefore, it might go to the High Court. There would be an appeal even to the House of Lords in the case of a *primâ facie* bad patent; but none, except from one Commissioner to three Commissioners, in the case of a good patent. More than that, you would have the Commissioners making their own practice and their own rules. When the patent was *primâ facie* good, it would be tried by these rules; but a *primâ facie* bad patent would be tried by another mode of procedure, and another mode of practice, namely, that in use at present in the High Court. Again, if an appeal were to be allowed from one Commissioner to three, how would that work? The Commissioner who knew most about the subject-matter was to try it first. If it were a chemical patent the chemist would try it, and the appeal would be, of course, to the two gentlemen who knew least about it, viz., the engineer and the lawyer, with the chemist. How would that work? They might be pretty sure that the opinion of the chemist, who knew most about it, would prevail, so that practically the appeal would be worth nothing. If there was anything in the principle of the Bill it was to get patents tried by gentlemen who knew the scientific part of it, or the practical part of it. If you did, you could hardly expect that the chemist would be over-ruled by the lawyer and the engineer. It was by no means a satisfactory form of getting an appeal from a single judge. But the Commissioners here suggested were wholly incompetent to try legal questions. What kind of questions would they have to try? Take for example an action lately tried, the case of "Rolls *v.* Isaacs;" that involved the question whether an invention used in the Colonies invalidated a patent in this country for that invention, and depended on the construction of the words "within this realm." A chemist would have to construe the specification, and determine what was the meaning of "within this realm." That was an example of which many more might be given. In the case of "Nixon *v.* The Small Arms Company," which was tried in 1877, and went to the House of Lords, it practically turned on a question of the law of agency, and that the engineer would have to try, because the lawyer would not have to try any of them. There were many other cases he might refer to if time allowed. Another point of great importance was involved in Clause 59, Part 4. These Commissioners, in the hearing of patent cases, might exercise all the powers which a Judge or Divisional Court of the High Court might exercise. He must assume the Commissioners knew what that included; it was not merely that they could do what a single Judge could do, but what the Legislature in their wisdom would not direct a single Judge to do, or the Judges in their modesty undertake to do, one at the time. That was not all. These Commissioners undertook in the 63rd Clause to make rules of procedure; the chemist, and the engineer, and the lawyer would undertake to enact a set of rules, and leave them to Parliament to settle. Just imagine the Judicature Acts left to the House of Commons to settle, for that was what it practically came to. They would have to make rules, for aught he knew, as long and complicated as the Judicature Rules themselves. Now, he would ask what might be done in the High Court at the present time, and contrast that with the proposed Court of Commissioners. At the present time, you might have a patent case tried in five different ways—by a Judge alone, by a Judge and jury, by a Judge and assessors, by a special referee or by an official referee. What were the complaints now made against this Court? There were two. First, it was said that the Judges would not try these cases; they were too complicated, they did not like them. If that were so, make such a law as prevented them sending them to a reference. At the present moment, if a patent case went into a Court to be tried by a Judge and jury, the Judge had no power to refer it, except to send it to the official referee, or to try it with the assistance of the jury. But why did it ever get into the Court before the jury instead of the best tribunals which could be obtained, viz., a Judge versed in the law, and one or two assessors who knew the practical facts of the case. It got before a jury because the parties to the action would not consent to its being tried by a Judge with assessors. The remedy was to make it compulsory, giving the Judge at chambers, or in any way, power to order that the case should be tried in the way it ought to be tried, viz., before a Judge and assessors. If that were done, you would have the best tribunal you could have, and more than that, you had all the other forms of trial to choose from, if you liked. There was only one more objection to trying in the High Court of any force, and that was the cost. Now, he had carefully read what Sir Frederick Bramwell had said before the British Association, and he there said the great cost of trying patent cases was the expense of models. Now, considering that you had an average of nine patent cases tried in the year what was the expense thrown away in trying them. To put an exaggerated figure, he would say £1,000 in each case, or £9,000 a year in the nine cases. Now, the report on the Patent-law Commissioners for the year 1880, showed that during that year the excess of income was £145,000. That came out of the pockets of inventors. Then they were to have this second part of the Bill thrust upon them as being important because of the cost of models, which at an exaggerated estimate would be £9,000 or £10,000. He ventured to appeal to the Committee, even if it were on no higher the ground than that of expediency, on behalf of the poor inventor, to put aside this second part of the Bill, because if they insisted upon it, they might be pretty sure the whole Bill would be thrown out. Was it not better to sacrifice the £9,000 a year, if it was so much, wasted in litigation in the course of the year, and take no notice of it, and to lay their fingers on the £145,000 and see whether that could not be dealt with. The poor inventor concentrated his attention on the third schedule of the Bill, and he thought he was quite right. The cost of an application was £2 10s., of the grant, £10, at the expiration of the fourth year £40, and at the end of the eighth year £60, that was what made up the £145,000 a year profit. If they reduced that and carried out the first part of the Bill, which was good in principle, well put, clear and intelligible, and not court opposition as the second part did, they might get that through, and save for the poor inventor a very large slice out of £145,000.

Mr. R. H. TWEDDELL said he could not enter into the matter with the same spirit as the gentleman who had just sat down, who proposed to shift the expense from one side on to the other, and reduce the fees for obtaining a patent instead of those for law; but being engaged in the question, both as a patentee and as a user, it might not, perhaps, be wasting time to mention one or two of his own ideas on reading this Bill. The points he proposed to touch upon, were briefly these. First, with regard to dormant publications; this proposal seemed to open up a very difficult subject, who was to decide what was a dormant publication. They were told that it was an excellent thing to pick up an invention out of the gutter and give it to someone to rear up; and Mr. Carpmael had remarked that even the Patent-office waste-paper basket might offer a prolific field for anyone who wished to explore. If anyone chose to search there, no doubt he might find many ideas crudely worked out, but he (Mr. Tweddell) certainly considered that if no other earlier publication could be shown except in the form of a provisional specification, that alone should not stop a patent being granted. If a man had only gone so far as taking out a provisional specification, others might as well make use of what he had described, but to destroy a provisional specification was a waste of material or brain power, which should not be encouraged, and was unnecessary. With regard to the question of the Commissioners, he could only say as a patentee not much engaged in litigation, though he had tasted the sweets of adversity, he would sooner have such men as would probably, under this Bill, be entrusted with such functions, either for or against him before the High Court of Justice, rather than have them sitting in judgment on him. He did not himself think that such a Court would command the confidence of either the user, the inventor, or the manufacturer. In the first place, taking it from the point of view of the inventor, whoever constituted such a Court would naturally be more or less of an inventor, and have been at some time more or less interested in trade. You might as well put Sir William Armstrong to judge on a Whitworth gun, or Sir Henry Bessemer to judge on the Siemens or any other steel-making process. If such gentlemen would even take the position, which nobody imagined they would, this would be the unfortunate state of affairs. Practically speaking, these Commissioners could only be described in the language of the Bill's new definition of subject-matter for a patent as new products or manufactures, not being natural products. With regard to the Examiners, this was a point which many inventors had various opinions upon. He thought an applicant had a perfect right, considering the sum of money now paid, to have his patent examined by Government officials. When a man now got a patent granted, he had no assistance given to him by the Patent-office to tell him whether it had been anticipated or not. He should not ask for any guarantee, but he has a right to have a search made for him. The French plan was, on the whole, a good one, which gave no guarantee from the Government at all. You had to trust in Providence, and you were better off then, than in trusting to an Examiner invested with authority, and as thick-headed as, according to Mr. Newton, such a person would naturally be. By this he meant that he should never think of introducing into this country any examination which implied more than searching for precedents, and giving the results of such search to the applicant; but they ought all to be done by the Government for the money which was now paid for every patent.

The CHAIRMAN said there was no suggestion that any fee should be paid for examination.

Mr. TWEDDELL said he supposed the proposed Examiners would have to be remunerated out of the fees to be paid; they would not work for nothing.

The CHAIRMAN said of course they must be paid by somebody, but he thought Mr. Tweddell was putting this as being a further tax on the patentees.

Mr. TWEDDELL said he thought the idea was to appoint Examiners, who were to exercise a sort of paternal care over the patentee, which was not exercised by the Government at present, and in his opinion never should be; but the proposed examination in its present form was open to grave objection, inasmuch as it implied the Government taking a certain responsibility such as ordinary specifications. What a patentee had a right to expect, was that a patent should, by aid of the Patent-office staff, be so drawn that it could not be upset on non-technical grounds, such as badly drawn claims and verbal inaccuracies or any defects, which ordinary care and and assistance could obviate. With reference to the duration of a patent, it was a question whether 21 years or 14 were sufficient; 21 years was not too long for a good patent, and there was a good deal to be said in favour of keeping the fees on the present scale, in order to keep frivolous patents out of the field. With regard to compulsory licenses, he thought the natural law of supply and demand should be left to settle that. You very seldom found that one man had sole possession of the field. If it were a good invention, it was almost certain to be followed by one running on nearly parallel lines. They had only to look at the various steel processes, artillery, electricity, &c., to prove that the public had lost nothing, practically speaking, so far, from the absence of compulsory licenses. They might just as well legislate to prevent the formation of rings and syndicates for the working of patents, many of them of doubtful validity, and this was more injurious to the poor inventor than the present scale of fees. With reference to the provisions with regard to the infringement, nothing but praise could be given to the common-sense proposal that a man should not be justified in upsetting an otherwise good patent, because he found one bad claim in it; and if nothing else had been done by this Bill, upon which so much trouble had been spent, that alone would be sufficient to justify its conception, and the consideration it had received. But, speaking generally, if he had but the eloquence of some of his learned friends who had already spoken, he could easily persuade them that the best thing that could happen would be that this Bill should never come before the country at all, but that the Committee should wait on the Government and bring the weight of their opinion to bear in asking for some reform. The Act of 1852 possessed quite sufficient ground-work to satisfy all reasonable patentees; it was by no means perfect, but he did not think there was very much wanted to improve it. Patent property was certainly as good as any other property; and he would sooner now have a 14 years' patent than landed property in Ireland; therefore, they had better not rush in and become as other men were, under Acts of Parliament which gave no security at all. At any rate, the result of the present discussion could only do good, and they were much indebted to the Committee, and to Sir Frederick Bramwell for putting the matter before them in such an interesting shape.

Mr. GEORGE BARKER (Birmingham) said he agreed n very great measure with what Mr. Tweddell had just said with regard to the Act of 1852, that with a few improvements it would satisfy the inventors of the present day. They ought to be very grateful to the Society of Arts for affording workmen an opportunity of expressing their opinion in that room, and he should like to ask a question of the meeting—probably it was overlooked very often in drawing up patent measures—who were the inventors themselves, for they very often did not comprehend who the inventors were. The larger proportion of inventors were working men, though very often they sold their inventions to manufacturers, and other people, and the patents were taken out in other names, although they knew a declaration had to be made that they were the true inventors, or the patentees themselves. Yet the making of a declaration was often looked upon as a very formal matter. If they referred to the Patent-office records, which were not altogether trustworthy in that respect, for the reason stated, still they would find that the greatest number of patentees were working men. Therefore, in legislating on this subject, they required first to know who they were legislating for. He should like to refer to the speech of the Right Hon. Joseph Chamberlain, president of the Board of Trade, on the second reading of Mr. Anderson's Bill, from the *Times* newspaper of the 16th June, in June last, when he was speaking as the mouthpiece of the Government, and foreshadowed what the Government measure would be when brought in. Mr. Chamberlain said:—"He was very sensible of the importance of the question dealt with, and everyone representing a large manufacturing community must know how keenly the hardships inflicted by the existing law were felt by inventors. Again, he said he was inclined to believe that the chief objections to the Patent-law were two. In the first place, the monopoly rights afforded by patents were not really enjoyed by inventors themselves, but by wealthy men; and that that was so was part of the consequence of the greatest defect of the existing law, viz., the exaction of excessive fees, especially those charged in the initiatory steps for taking out patents. The fees were so high that a poor man was almost compelled to have recourse to the resources of capitalists who, of course, expected to derive some benefit from the transaction." What Mr. Chamberlain had said should have very great weight with the framers of the measure; he was sure they had no wish to draw up a one-sided Bill at all, but to elicit the opinion of working-men as well as others, and to prepare a measure which would be at least a guide to Mr. Chamberlain in bringing forward his Bill. With regard to the cost under the Society of Arts' Bill, it would give an annual surplus income of about £75,000, that is, taking the number of patents as they stood this year, the income would be, under the proposed Bill now under discussion, £120,000, or a surplus of £75,000; and he would now read what Mr. Chamberlain said in regard to that point, viz.:—"He was informed that if the reduction which his hon. friend suggested were adopted as it stood in the schedule to the Bill (meaning Mr. Anderson's Bill), the fees would not pay the actual cost of working the Patent-office, unless there were immediately a very large increase in the number of applications." He (Mr. Barker) questioned the accuracy of this computation, and Mr. Chamberlain did not pledge himself to this opinion, but it was the opinion of the officials; but, at all events, he agreed in the principle laid down, that in making the reduction regard should be had only to the necessity of paying the actual expenses of the office. Now, he really did not see why the framers of this Bill, seeing that Mr. Chamberlain foreshadowed that as his intention, should give a surplus income of £75,000. With regard to the extension of time for provisional protection, Mr. Chamberlain also expressed himself to the effect that it was too short; yet in reality the extension of time now proposed was only very trifling, viz., from six to nine months, and the complete specification must be deposited before the end of six months, which scarcely gave the inventor any advantage over the present system; the protection now proposed really extended to nine months, with power to the Commissioners to extend it to twelve. He thought that was too little, and that the provisional protection should be for twelve months. What the working man lacked most was probably time— at any rate, quite as much as money.

The CHAIRMAN reminded Mr. Barker that the period of nine months in Section 11, and three months in Section 13, were in italics, indicating that the Committee hardly expressed an opinion upon them. He was glad to hear the views of any gentleman upon this point.

Mr. BARKER said he had had many inventions, and had had a lengthened experience with working men; he knew their requirements, and he was speaking now from their point of view, though he might have spoken from another standpoint.

The CHAIRMAN reminded him that until the provisional specification was filed, a patentee would have no right of action against an infringer; therefore, the longer it was delayed, the longer was the patentee debarred from his power of stopping infringers. Both points had to be borne in mind.

Mr. BARKER said he was aware of that, but time and money were the two great wants of poor inventors; a man was tied at his work from six in the morning till half-past five in the evening, and often had to work overtime, and, therefore, time was very scarce with him. The foundation of a good Patent-law should be easy access to reliable information, and that might be covered by some compulsory clause in the Bill, requiring the Commissioners to publish a journal. There was some allusion to it, but this was too vague. There was, in page 15 of the Bill now before us, power given to the Commissioners to publish what they should think well from time to time; but he thought it should be positively stated in the Act that illustrated abridgements should be published as an appendix to the journal, and that the price should not exceed its present price of 25s. per annum, post paid. Supposing the cost of this appendix were £10,000 per annum, it would be money well laid out, and would become the foundation for a reference of the most reliable kind, and also an index to the specifications in the public libraries, where so many inventors would have access to this journal. It would probably have to be four volumes per annum instead of two, the appendix being properly indexed, and bound separately; the inventor could thus ascertain whether his patent was a new one or not. It was very important indeed that inventors should have access to reliable information, and there would then be less need for examinations. He thought there should be an examination of the applications, but it should be as an auxiliary and help to the inventor, and solely with that view, and that a report of the examiner should be laid before the inventor, to assist him in amending his specification but no endorsement of his specification as proposed by the Societies Bill. He also thought that the first period of four years was too short. With regard to that, Mr. Chamberlain said "he was inclined to agree, that the third year was too early to make the second large payment; without pronouncing positively on the subject, he thought that payment might fairly be postponed to the fifth year." Now, why should they go back from what the Government were prepared to do? It was the initiatory period which taxed the inventor so very much. He had an invention now, which was nearly at the end of the third year, an invention fo guiding gas-holders with a central column instead of outside columns. He read a paper on the subject before the Society of Gas Engineers a year and a half ago, and there was nothing brought against the system at all; indeed nothing could be said against the principle under discussion; in fact, the paper was really not replied to, but the difficulty was in experimenting. An experiment on the central principle would cost about £12,000, which was a very serious thing.

The CHAIRMAN said he supposed Mr. Barker would not like a patent like his rejected because he could not get it into operation within three years.

Mr. GEORGE BARKER said no, and he did not like paying the £50 stamp duty so early. That was really a substantial grievance, and when the present Government were prepared to extend the period to five years, he thought at least the Committee who had drawn up this Bill would be glad to make such alterations in it as at least would not be going backwards. The initiatory stage was the important stage; at the end of five years, an inventor did not care so much whether he paid £30, or £60, or £100, although he should be inclined to follow Mr. Chamberlain, and say that the fees should only cover the expenses of the Patent-office. Now, there were 6,000 applications every year. If £5 was the amount charged for the application and five years' patent, that would produce £30,000 for the first stage alone. If the charge at the end of the fifth year was £10, and only 2,000 proceeded so far, that would produce £20,000 at the end of the tenth year, they would get another £20,000 by charging £20 for 1,000 patents proceeded with after that stage. That would give an income of about £70,000, which would allow of the £10,000 being spent on the Commissioners' journal, and £10,000 for examinations, and still leave a surplus. With regard to the extension of the patents, that also was very important, and he might again refer to his gas-holder patent. Supposing he did not fix one for another five years, on account of the difficulty of experimenting; at the end of 14 years he would not have had a proper opportunity of realising an adequate benefit from the invention. Now, in any extension of time, the risk that was run by the inventor should weigh very heavily with either the High

Court or the Commissioners; it should not be a question of profit only; the risk the inventor ran in the first place should be taken into account, and the question of extension should not be decided by his having made £10,000 profit.

The CHAIRMAN said there were still a large number of gentlemen who desired to speak, and it would be only respectful to those who had spoken that he, as Chairman, should answer the observations which had been made; he, therefore, thought they must again adjourn the discussion. They had already taken preliminary steps for urging on the Government to adopt so much of this Bill as might be approved, and, to enable the final steps to be taken, it was desirable that the discussion should be closed as early as possible; the adjournment would be to the first possible time, viz., that day week. A great deal of good had been done already; they had had many clauses discussed in a practical manner, and he might say at once, on the question of fees, there was no no desire on the part of the framers of the Bill to make them less favourable than the Government were intending to do. The plan the Committee had adopted was to take the fees fixed in the last Government Bill, only varied to such an extent as to apply to seventeen years' duration instead of to twenty-one; but they by no means put this scale forward as representing the settled views of the Committee as to fees. In fact, they left this question to be dealt with by those who had to consider the public revenue and public opinion.

The discussion was then adjourned until Thursday, December 22nd.

Miscellaneous.

PATENT AND SAMPLE EXHIBITION AT FRANKFORT-ON-THE-MAIN.

The idea of an industrial exhibition for Frankfort-on-the-Main, the commercial capital of Southern Germany, originated with the Chamber of Commerce. Many schemes were proposed, but, ultimately, the Exhibition was restricted to inventions patented in Germany (which now number nearly 10,000), including samples of the articles produced. As Frankfort is specially interested in the protection of invention, it was thought that this would give the opportunity of bringing inventions before the public, and of facilitating arrangements for their practical working. Sections of local industry, horticulture, "balneology" including mineral waters, and historic art were afterwards added. A guarantee fund of 300,000 marks (£15,000) was subscribed, and the direction of the enterprise was entrusted to Herren Schiele, Blumenthal, and Bolongaro-Crevenna.

The main building, and also that for the balneological exhibits, are erected of timber, on a piece of ground between the Palmen-Garten and the Villa Leonhardsbrunn, which latter was utilised for a temporary show of fruit and vegetables. The plan of the main building is a semi-circle, with a rectangle added on to its diameter; and it was intended that each of the alleys radiating from the centre should be appropriated to a separate group of exhibits. This was, however, found inconvenient in practice. The local exhibits only were arranged in one department; and separate sections were formed for France, Belgium, and Austro-Hungary.

The classification of objects comprises thirteen groups, which are as follow:—I. Textile fabrics and clothing. II. India-rubber and leather goods. III. Paper trade. IV. Wood and furniture industry. V. Glass and ceramic ware. VI. Hardware and miscellaneous articles. VII. *A*. Metal work (iron, zinc, nickel, copper, &c.). VII. *B*. The noble metals and jewellery. VIII. *A*. Steam-boilers and fire-grates. VIII. *B*. Steam, gas, hot-air, wind and water motors. VIII. *C*. Machines and appliances for flour-mills, breweries, distilleries, sugar-houses, mines and works. VIII. *D*. Transport machinery and implements. VIII. *E*. Various machines and appliances, tools, pumps, waggons, ventilators, water-meters, &c. VIII. *F*. Land and household implements. VIII. *G*. Accessories and parts of engines and machines, inventions. IX. Building and civil engineering. X. Chemical industry and food. XI. Scientific instruments. XII. Musical instruments. XIII. Graphic art.

This exhibition contains the original models of the first electric telegraph, and also of the first electric telephone, ever made. Sömmering's telegraph, made in 1809, was shown by his grandson, a copy having been contributed to the Electrical Exhibition, Paris. The telephone of Philip Reis, professor at Friedrichsdorf, near Hamburg, made during the years 1861-3, has a rude model of the ear, in wood, for the transmitting instrument. A. Rettig (Saarbrück) sent his *Fern-hörer*, or *tone-bringer*, an instrument (the converse of the speaking-trumpet) for catching sounds from a distance. It consists of a tube of paraboloid form terminating in a cone. E. Hoese (Rostock) exhibited his contrivance for determining the position of conflagrations by night, by a series of tubes like telescopes, though without lenses, mounted on a post, and directed towards various prominent points. Arthur Burckhardt (Glashütte) was awarded a gold medal for his calculating machine, in which the operations of both multiplication and division can be performed. W. E. Fein (Stuttgart) had on view a large collection of electrical instruments, including single and double telephone, a new microphone, a manganese battery cell, a regulator of electricity, and a telephonic signal clock. Hermann Kolbe (Hamburg) contributed a thermometer with electric alarm and automatic contact. Carl Pieper (Berlin) sent his thermograph for determining the relative value of lubricants, by registering the minimum temperature of a revolving shaft. H. Heid (Frankfort) received a bronze medal for his *cadenzmesser*, or watch with extra hand for beating time, to enable a drill-sergeant to give correctly the word of command, "Right, left." The firm of Siemens & Halske (Berlin), who entered as honorary exhibitors, sent a large number of instruments and appliances, among which may be mentioned a rotary steam-engine combined with dynamo-electric machine, for working five differential electric lamps; a telephone with magnetic equilibrium of the vibrating parts, and another with trumpet call; the model of a revolving switch arrangement for railway points, to be worked by wire connections, permitting the points to be opened by the heel; an appliance for separating magnetic from non-magnetic bodies; a telegraphic instrument for steering vessels; and the model of an electric postal arrangement for letters and small parcels. The new electrical machine, called "influence machine," of A. Dun (Frankfort), on the system of Dr. Holtz, attracted much attention, as it produced sparks thirteen inches long. Léon Somzée (Brussels) contributed a miner's safety lamp, with electrical indicator of fire-damp, which gives warning of the approach of danger long before the flame is visibly affected.

The artificial indigo of Dr. Bayer (Munich) was shown, with the raw materials and sub-products, by Meister, Lucius & Brüning (Frankfort). A new method of usefully employing cork refuse was shown in the "cork stone" of Grünzweig & Hartmann (Ludwigshafen). They preserve from damp and indurate the exterior surface of cork chips by immersing them in silicate of soda, and then form them into blocks by means of lime. The bricks possess greater solidity than might be supposed. Their advantage is that they are non-conductors of heat and sound; and their lightness admirably adapts them to form a partition-wall above a large room. Another application to building purposes of a substance hitherto but little used, was shown by Stauss & Ruff (Cottbus), who employ common reeds united by wire, instead of laths, and also form partitions with a double row of reeds containing plaster between. The air contained in the reeds prevents sound and cold from penetrating. A transportable apparatus for field irrigation, without previous levelling of the land, was shown, complete and full-size, by George H. Gerson (Berlin). Sewage and other liquid manure, which is too little concentrated to be carted with profit, but is more fertilising than river water, may, by this system, be applied to the land at a first cost of £5 10s. per acre. The advantages consist in the preservation and rapid absorption of the fertilising elements, especially ammonia, which is more or less volatilised in other systems, and in the retention of the original surface mould. The irrigation may, it is asserted, be carried on at any time of the year, in any climate, and to the greatest extent in winter. Steam or horses are employed instead of hand labour; unprofitable roads are superseded by ditches one-seventh the area; and the apparatus may be transported to various places, as occasion requires. From the ditches the sewage is conducted by wrought-iron pipes, forming the axles of light wooden wheels, readily connected to one another, while branches from these terminate in smaller distributing pipes (also on wheels), in which a lateral slot is marked by a shield.

In the grounds were a great variety of rails for permanent way, chiefly fixed to rolled iron sleepers. Joseph Vögele (Mannheim) sent a model of his arrangement of safety points, in which one rail is turned right over on its side, clear of the engine wheels, when the train is not to be directed on to the siding. G. Thomas (Mayence) received a gold medal for his combined locomotive and carriage, for light traffic on main and branch lines, used on the Hesse Ludwig railway. Of several automatic safety couplings, the most practical is that of H. Linn (Biebrich), in which the mere impact of the trucks or carriages causes them to be connected by four horns of one engaging with four horns of the other.

There was no special class of lighting, heating, and ventilation; but inventions under these heads were included in Group IX., Building and engineering. Besides a large number of the German earthenware stoves, that take a long time to heat, but which when once heated remain so for a long time, two or three new stoves demand notice. The Eisenwerk Kaiserslautern showed a ventilating stove, to be placed so that the coal may be fed through a spout at the back from a hall or passage. A supply of fresh air is heated and passed into the room without being burned. F. P. Lammerz (Bonn) sent a slow combustion stove, having an inner chamber of inverted slightly conical shape. This is filled with coke, which gradually falls down, and only burns at the bottom where the air has access. The flue of the Mannheimer Eisengiescrei is arranged in diagonals crossing one another, thus affording a large heating surface to the air, which is directed into the angles. Among the ventilators was a new one the "Œolus," sent by A. Kind (Berlin), in which a stream of water in the form of a cone, and in a finely divided state, draws the air along with it, besides refreshing it and, to a certain extent, depriving it of impurities.

Besides the four large steam-engines, all of the horizontal type, used for driving the machinery in motion, several prime motors for steam, gas, and hot-air were exhibited. A new water-wheel, by J. H. Müller (Hamburg), has a slightly inclined axis, and receives, in half-moon-shaped buckets, the water flowing from above, utilising, it is claimed, from 80 to 85 per cent. of the theoretical effect. L. Purper (Paris) erected his new wind-motor, "the tourbillon," based upon a new theory, that all the winds act from eight directions, N., S., E., W., and the intermediate points. Besides the four, six, or eight vanes, he erects fixed screens with the view of condensing the wind, of intercepting that portion which would interfere with the rotary motion, and of changing its direction so as to add to the useful effect. An ingenious sewing-machine motor was shown in action by W. Hoffmann (Mühlhausen), in which the weight of the operator is transformed into rotary motion. Among the many lubricators exhibited, that of Joseph Patrick (Frankfort) merits notice for the ingenuity of its design; the flow of oil is regulated by the unequal contraction of two metals, steel and gun-metal, so that the higher the pressure, the more oil flows, until the reduced heat again checks the flow.

A complete set of boot and shoe machinery was shown in operation by Weber and Miller (Frankfort). An ingenious machine, worked by hand or power, for cutting out to pattern several thicknesses of all kinds of textile fabrics, and also leather, was shown in action by Philippsohn & Lechziner (Berlin). It consists of a table mounted on frame, and a standard, or pillar, to which is jointed a horizontal arm; and this, in turn, carries a prolongation jointed to it. From the end of the second arm depends a spindle carrying a small disc of steel, which is made, by gear and belting, to revolve very rapidly. This can be made by the hand to travel in any direction, and describe inside and outside curves, thus cutting out the fabric exactly to pattern. A great advantage of this machine is that the cutter is brought to the work, instead of the work to the cutter. The same principle is adopted in a metal drilling-machine shown by the Nöll'sche Waggonfabrik (Wurzburg), which can, therefore, be immediately adjusted so as to drill a hole anywhere within its range.

The Brothers Pfeiffer (Kaiserslautern) exhibited in operation a machine for taking the impression of patterns in sand, for forming metal castings. By an ingenious arrangement of gear, the pressure increases while the speed diminishes, with a uniform speed of the power applied by hand or motor. It is claimed that this appliance effects a saving of 75 per cent. over hand labour, while that employed need not be of the skilled class. Volpp, Schwartz & Co. (Freiburg in Baden) showed, in practical operation, their machines for automatically cutting the facets of tumblers and other glass articles, thus superseding the unhealthy work of hand glass-cutting. The work is, besides, performed at about half the usual cost, and with mathematical precision. Erasmus Helstein (Thann) contributed a model of his automatic machine for making paper tubes, such as cartridge cases. Krummerein & Katz (Stuttgart), showed, at work, a self-acting machine for setting and sharpening saws at one operation.

It remains to notice one or two minor exhibits, which, however, possess considerable interest. Both A. Lickroth & Co. (Frankenthal) and L. G. Vogel (Dusseldorf) showed some school forms which are pivoted near the floor, so as to swing back under the desk and allow passage between two desks. C. & R. Schmidt (Elberfeld) showed some pressed pasteboard dishes, in five sizes, either plain or variously ornamented. They were used in the temporary exhibition of fruit, for which they served admirably. H. Granel & Co. (Magdeburg) sent some air-tight caps for bottles, in which an earthenware plug surrounded by india-rubber is riveted to a hinged flap of metal. The hinge is attached to a wire surrounding the neck of the bottle. On the opposite side of the wire ring is hinged a catch, which clips the flap owing to the spring of the india-rubber.

The exhibition buildings are to be used next year, for an Exhibition of Textile Industry, when it is hoped that the loss resulting from the Patent Exhibition will be recouped.

ELECTRIC LIGHTING BY WATER-POWER.

Mr. Thomas B. Grierson read a paper on this subject, before the Institution of Civil Engineers of Ireland, on the 7th inst. The author remarked, that "many towns in Ireland, which at present are not lighted at all artificially, owing to the enormous first cost of a gas works, as well as the high price of coal, or perhaps, the number of would-be consumers being too small to pay working expenses, might, by utilising the water-power at their disposal, light their streets by electricity at a very small cost indeed." After describing dynamo-machines, lamps, &c., he gave the following account of the immediate subject of his paper, namely, the advisability of applying water-power for producing the electric potential:—"In a country like Ireland, where we have to import almost all our coal, and that at very great cost, it would never pay to adopt steam as the sole motive power, at least to such an extent as would be necessary if every town were lighted by electricity, because, with the demand, the price of coal would increase, probably to such an extent as to preclude the possibility of its use. In France and Germany this difficulty as to steam-power also arose, but with the result of producing highly economical machinery for utilising the water-power of those countries. And here, it may be mentioned, that this fact is sometimes cited as a proof of the truth of the saying, 'that every country bears upon its surface the power to direct the genius of her sons.' And so England, with her enormous coal measures to work it, has produced, through the genius of James Watt, the magnificent steam-engine; whilst France, with unlimited water-power, but scanty coal supply, has brought forth the turbine—one of the most, if not *the* most, economical water-motors of the present day.

"In Ireland, as was said before, where coal is scarce but water-power is plentiful, there would be nothing to prevent the utilisation of the latter for a great many industrial purposes, much less for the driving of dynamo-electric machines. And when we recollect that the total water-power of Ireland, according to the estimate of Sir Robert Kane, who went carefully into the subject, is equal to the enormous amount of one million and a quarter horse-power, we must surely censure ourselves for our want of enterprise in allowing this stupendous amount of energy to run uselessly to waste. The horse-power is here assumed to be equal to 12 cubic feet of water falling one foot per second—equal to 45,000 lbs. falling from a height of one foot in one minute, or about one-third more than the standard fixed by Watt, the one-third being intended to allow for friction. The allowing of this immense power to expend itself uselessly cannot be said to be due to the fact that water-power is less economical than steam-power, quite the contrary, for water-power has been shown over and over again to be much less costly, either in first cost of machinery or afterwards, to work with.

"A great argument in favour of the economy of water-power is to be found in the fact that, in England, where there was little need to economise coal, it being so very cheap, and the cost of steam-power at a minimum, that, notwithstanding, water-power has been largely utilised wherever it was at all possible to do so. One river, the Irwell, which passes Manchester and Bolton, having coal on each bank, is said to be probably the hardest worked stream in the world, it having between Bacun and Prestolee, near Bolton, a total fall of 900 feet, 800 of which are actually utilised. In the year 1839, one-ninth of the total mill-power of Lancashire was water-power; also in the same year, according to the returns of the Factory Inspectors, out of the total mill-power of England, subject to inspection, one-fourth was water-power.

"The late Mr. Robert Mallet, Past President, some years ago, having also gone carefully into this subject, in reporting to the Board of Works upon the rendering of the water supply of the river Dodder more uniform, stated that the cost of water-power would be about one-tenth of the cost of steam-power. Sir Robert Kane also, in his 'Industrial Resources of Ireland,' speaking of water as compared with steam-power, says:—'It is certainly much cheaper, not merely in Ireland, but in all places where it is available.' And again he says:—'An eminent manufacturer in Leeds said to me that water-power is cheaper than steam-power at the pit's mouth.' Mr. Fairbairn also, in reporting upon the great reservoirs which he, in conjunction with Mr. Bateman, constructed some years ago upon the river Bann near Killaloe, said that the cost of steam-power was from £20 to £30 per horse-power, whilst water-power could be had for £3 per horse-power per annum, or, as he says, an average of about one-eighth. Mr. Bateman, however, goes farther than this, and says he believes, if there were properly-constructed reservoirs to keep the supply constant, that water-power would not be more than one-twentieth the cost of steam-power.

"Many other instances might be given to prove the economy of using water-power, especially in Ireland. In a paper on dynamo-electric machines, read at the Institution of Civil Engineers, in January, 1878, by Dr. Higgs and Mr. Brittle, Associates Inst. C.E., it is stated that the greatest economy in driving the dynamo machines was found to be with a turbine as the motive power. But, even if water-power were not so extremely economical, as it undoubtedly is, there would be a great deal to be said in favour of utilising it to the utmost degree possible, leaving coal to be used in those places and for those purposes for which it is absolutely required. This would tend to reduce the cost of coal by lessening the demand, and the result would probably be that, in those exceptional districts where water was not available, steam-power could then be had at a much less cost than at present. It would also have the effect of reducing the cost of goods in the manufacture of which coal is indispensable—not to speak of the benefits which the poor would derive directly from such a reduction in the cost of coal.

"That water-power will be made available in the future to a much greater extent than it has been in the past we may safely predict, for already there have been several instances of turbines being applied to the driving of dynamo-electric machines, notably that of the small town of Godalming, on the river Wey, where a very successful series of experiments has just been made with a view to the permanent lighting of the town by electricity, making use of the water-power close at hand for the purpose. This town is an instance of, as has been pointed out in the beginning of this paper, a small town in which coal is very dear, it having to be brought from a great distance, but with plenty of water-power close at hand.

"Although the estimates given above, in his comparison of the relative costs of water and steam-power, are based on the assumption that collecting reservoirs would be required to keep the head uniform, still there are a very large number of places in Ireland where no such collecting reservoir would be absolutely necessary, as, for instance, in the case of a deep and rapid stream of fairly uniform depth, the power might be calculated for the minimum head in dry seasons. This could easily be done by making the turbine adjustable, so that in the case of flood time, when the pressure was great, only one ring of the buckets might be opened, and when the water was at its minimum level the full power of the turbine could be utilised—thus making up in quantity what was lost in head, and *vice versa*—and so keeping the speed of the turbine practically constant.

"But perhaps the simplest way to apply water-power to work turbines would be to take the power from a higher lock of a canal discharging at the lower level. This would give a practically constant head, and of course uniform speed, to the turbine. Many towns, through which the canals run, might thus be very economically lighted, to the advantage of the inhabitants as well as the canal shareholders. And what is to prevent such an arrangement being successfully applied to a City like Dublin, where, with splendid canals on both sides, low pressure turbines could easily be fixed to drive dynamo-electric machines—the wires conveying the current being carried into the city to supply the lamps? In such an event the author believes the saving effected would be enormous. Again, the Vartry water might be made available for the driving of small high-pressure turbines, or water-pressure engines—the latter would, however, relatively require to be more powerful than the former, owing to their slower speed—so as to drive from a correspondingly large pulley in order to get up the high speed required for the dynamo-electric machines, which, to work at the high pressure of the Vartry, could be made so small as to cost very little indeed; for instance, a turbine with a wheel five inches in diameter could be fitted up for about £35, and would require, in order to develop about two horse-power, about 800 or 900 cubic feet of water per hour, whereas a water-pressure engine, to do the same work, would cost about £80 fixed, but the revolutions of the turbine would be 2,000 per minute, while those of the water-pressure engine would be only 30 in the same time. Of course the author is not prepared to say that the supply of Vartry water would be sufficiently great in quantity to meet such a demand upon it; but perhaps our President, than whom no person should know better, will give us some information on the point.

The principle, however, of conveying power to great distances in the form of water under high pressure is sound, it having been found to be a more economical way than any other—indeed, when the subject was discussed in the Institution of Mechanical Engineers, nearly all the members present were unanimous in its favour. In proof of this we have only to look at what has been done by Sir William Armstrong and others, where the water-power has been carried to a distance of several miles in some instances for the working of cranes and other machinery by hydraulic power. And here it may be mentioned, more as an historical fact than as absolutely bearing upon the subject, that many years before Sir W. Armstrong applied his method of accumulating and conveying power in practice, the late Mr. Joseph Bramah, the inventor of the hydraulic press, wrote to the late Mr. Robert Mallet, then a manufacturing and consulting engineer in Dublin, stating that he was prepared to apply his method of storing and conveying water-power to the working of cranes and other machinery on the quays of the river Liffey, just as has been done of late years by Sir W. Armstrong. Bramah's letter will be found in the Proceedings of the Institution of Mechanical Engineers.

TOBACCO MANUFACTURE IN FRANCE.

By the Imperial decrees of December 29th, 1810, and January 12th, 1811, it was ordained that the purchase of tobacco in leaf and the fabrication and sale, whether wholesale or retail, of manufactures of tabacco, should be exclusively confined to the Administration of Indirect Taxes (Régie des Droits Unis) in all the departments of France. At present the régie has in operation sixteen large manufactories, twenty-seven "magasins de culture," and four "magasins de transit." It employs over 19,000 workpeople, of whom about 80 per cent. are women and girls. The usual daily earnings are, for men, from 2s. 7d. to 3s. 11d., and for women, from 1s. 2d. to 2s. 4d. For faithful or exemplary services, the workpeople receive annually rewards, varying in amounts from 15s. to £20. Mr. Scidmore, the United States Consular Agent in Paris, gives the following description of the manner in which the operations of the "Régie" are carried on. At the beginning of each year the Minister of Finance designates the number of hectares upon which, and the departments within which, the cultivation of tobacco may be undertaken during the following season. The last ministerial decree upon this subject confines the privilege to the departments of the Alpes Maritimes, Bouches du Rhône, Dordogne, Gironde, Ille-et-Vilaine, Landes, Lot-et-Garonne, Meurthe-et-Moselle, Nord, Pas de Calais, Puy de Dôme, Hautes-Pyrénées, Haute-Saône, Savoie, Haute Savoie, and Var. In the month of October or November, an agent of the "Regie" proceeds to the communes among which the prefects have apportioned the allotments, and receives the declaration of every proprietor desiring to profit by the authorisation. A Commission, composed of the prefect, of the director of indirect taxes, a superior agent of cultivation, a member of the council general, and of a member of the council of the arrondissement, not being planters, then examine the declarations, and admit, reduce, or reject them. After a planter is accorded permission to cultivate, he is subjected to close official supervision, and to numerous stringent regulations concerning details as to the prohibition to sow any other seed than that furnished to him by the administration, the mode of planting, &c.; and, in addition to the surveillance as to these matters, two official inventories are taken of the growing crop—the first to ascertain the extent of land under cultivation and the number of plants, the second to determine the number of leaves for which the planter will be held accountable. When the tobacco has been gathered in a manner described by regulations of minute detail, the planter takes it to the magazine of the "Régie," where it is subjected to the inspection of a commission of five disinterested experts, who separate the leaves into three portions, according to quality; the planter is then paid for each portion in accordance with the tariff of prices promulgated by the Minister of Finance. Foreign tobacco is obtained through contract with private parties, after published proposals by the Minister of Finance through the French Consular Corps abroad, and through a special government agency established at Havana. At present a little over one-third of the tobacco purchased by the "Regie" is of French growth; over one-half consists of foreign leaf, mostly obtained from the United States, and the remainder is made up by importations of cigars from Havana and Manilla, and by cigarettes and miscellaneous productions of various countries, and by Customhouse seizures. The magazines distributed throughout the country are of two sorts, "magasins de transit" for foreign tobacco, and "magasins de culture" for indigenous tobacco. In the "magasins de transit" the foreign leaves have not to submit to any other manipulation than the sampling of packages, after which they are forwarded to the factories in such quantities as may be demanded. With the indigenons tobacco the course is different; this when received from the hands of the French grower is usually very imperfectly dried, and has to be subjected to a curing process. After the bundles are thoroughly thrashed, they are put in heaps according to maturity, and fermented in a temperature as high as 30° to 40° Centigrade. This maturation lasts from six to nine months, depending upon the locality, and the condition of the leaves as received, and is interrupted from time to time by the operation of shaking and turning in order to prevent too great fermentation. When this fermentation is concluded, those leaves containing less than twenty per cent. of water are ready to be packed. At this point certain of the leaves undergo a stemming process, they are then packed by hydraulic pressure in bales and hogsheads, weighing from 400 to 500 kilogrammes each, and in this state they remain stored in the magazine for some months to acquire further ripeness. It is usually from fifteen to eighteen months after they are gathered, that the leaves are considered to be in a fit condition to be sent to the manufactory. Upon their arrival at the factories, the packages are sorted and opened, the leaves are then spread out in large bins, and receive the preparatory wetting with water containing ten per cent. of marine salt, in order to produce flexibility and to prevent powdering. This process occupies twenty-four hours. Then follows the sorting according to quality, and the distribution to the various workrooms for composition. When intended for the manufacture of snuff, the leaves are put into machines and chopped into strips of the width of a finger; they are then moistened with pure water or tobacco juice of various strengths, the necessary quantity and quality of which is determined by chemical analysis. These strips are then piled up in masses containing from 35,000 to 40,000 kilogrammes, in rooms where a high and even temperature is maintained by steam-pipes and ventilators. Here they remain to ferment during a month or six weeks, when they are dried, ground into powder, and sifted. This powder then receives a wetting, is packed in stout wooden bins, in quantities ranging from 25,000 to 30,000 kilogrammes, and so remain to ferment for several months. During the course of the final fermentation, the powder is tested and moved from one bin to another from time to time, in order to insure a successful issue of the process. When the samples taken from the bins indicate maturity, the snuff is packed in barrels and casks, and is ready for the market. For the manufacture of smoking tobacco, the leaves, after the stemming process, receive their first moistening, which lasts twenty-four hours. They are then neatly arranged, with their edges parallel, and are taken to the chopping machines; the machines in use at the "Régie" are capable of chopping 220 pounds per hour, the knives being renewed twice during that time. The tobacco, on leaving the choppers, contains about 25 per cent. of humidity, and is immediately conveyed into one end of a revolving drying cylinder, heated to a uniform temperature of 203° Fahrenheit, from the opposite end of which it issues, at the expiration of fifteen minutes, in a dried state and freed from albumen. It is then put through a second cylinder, similar in construction to the last, but which subjects the tobacco to a strong draught of cold air to eliminate all dust and heat. The tobacco is then packed in well-aired bins where it remains from four to six weeks, after which it is carefully overhauled by hand to remove the pieces of stems and foreign matter that may have escaped notice in the previous operations. It is then put up in packages, varying in weight from 40 grammes upwards. These packages are surrounded with a paper band, upon which are printed the Government tax stamp, the date of manufacture, the weight, the price, and the letter "H," followed by figures. The last mark signifies the amount of humidity contained in the tobacco at the time it was put into the packets. Consul Scidmore says that in no instance since its inauguration has there been a year without enormous profits to the tobacco monopoly in France, and in a table appended to his report, it appears that from the date of its foundation (1811) to the end of 1878, the net total gain to the French Government amounted to £287,703,881.

CINCHONA CULTIVATION IN JAMAICA.

The Government of Jamaica appear to be very desirous of encouraging the cultivation of cinchona, and they have made arrangements for the grant, under certain conditions, of a limited extent of land, at a nominal price, to any person who may be prepared to embark in the undertaking. Further particulars of the progress of cultivation have been received since those already printed in this *Journal* (vol. xxix, 240, 455). The demand for seeds and plants is said to continue to increase largely, as the new industry brings into productiveness regions which in many cases were unsuited for coffee or provisions, and which were a burden on the owner. Mr. D. Morris, the Director of Public Gardens, writes in his last report:—"As indicating the value of cinchona planting in the Blue Mountains—taking 379 trees which occupied an area of less than 120 square yards—it was estimated that if they yielded on the average one pound of dry bark per tree (young trees at the Government Plantations yielded 1½ pounds per tree), each tree would be worth at least 5s.; this would give £94 15s. as the value of 379 trees on an area of 120 square yards, one-fortieth of an acre. Under ordinary conditions it would not, however, be advisable to plant the trees so closely as this, but the value of an acre of land planted with trees even at one-half the above rate, would amount to more than £1,890. Large as this sum may seem, it appears that with the precious Ledgeriana bark, grown by the Dutch in Java (a few plants of which have just been introduced to Jamaica), the yield per acre, as quoted by Mr. J. E. Howard, F.R.S., is estimated, from actual sales, at £2,000 per acre."

Three kinds of cinchona are now well-established in Jamaica, viz., *C. officinalis*, *C. succirubra*, and a variety called *C. calisaya*, which is supposed to be a hybrid between the other two. The *ledgeriana* is a variety of *calisaya*. Seeds of the *C. officinalis* for cultivation at elevations above 4,000 feet, are supplied by the Government at 5s. per ounce, of *C. succirubra* at elevations between 2,500 and 4,000, at 3s. per ounce. An ounce is sufficient to produce 20,000 seedlings, which will plant five acres. Boxes of seedlings may be obtained at a guinea per box, and plants are obtainable at from 40s. to 60s. per 1,000. The following particulars of the cost of forming a cinchona plantation based upon actual experience has been drawn up by Mr. Morris. It is understood that the land is taken up under the recently published system of grants made by Government, and that no buildings are required beyond labourers' barracks, sheds, and a small house for the headman or overseer. The plants are supposed to be *Cinchona officinalis* planted at 3½ feet by 3½ feet, giving 3,500 plants to the acre. If only about 5 acres are intended to be opened, the relative cost will be a little more than the following: whereas if a larger area is opened and nurseries established on the spot the relative cost will be considerably less. Also, when the plantation is opened from a neighbouring plantation, the cost of superintendence will be much reduced.

Detailed Statement of Expenditure on a Cinchona Plantation in Jamaica for Planting 5 to 50 *Acres of "Cinchona Officinalis"* 3½ *feet by* 3½ *feet, with* 3,500 *Plants to the Acre:—*

	Per acre.		
	£	s.	d.
1. Prime cost of land (2s. per acre according to terms offered by Government, and incidental expenses for surveyor's fees, &c.	0	5	0
2. Cutting down forest, burning, and clearing ready for planting (contracts according to nature of forest and locality). Some as low as £2 per acre, and some as high as £5, say	4	10	0
3. Lining, 8s. per acre; pegs (3s. per thousand), 10s. 6d.; holing (50 large holes for 1s.), £3 15s.	4	13	6
4. Plants, 3,500 to the acre; if raised in nurseries on the plantation itself, about 25s. or 30s. per thousand; if bought, probably 40s. to 45s. per thousand. Cost say for an acre of 3,500 plants.	7	0	0
5. Planting by day labour, shading, &c.	3	0	0
6. Staking, weeding, and supplying to end of first year	2	5	0
7. Share of superintendence	1	7	0
8. Barracks, house for headman, roads and field paths, weeding and supplying up to the end of the fourth or fifth year, when plantation begins to yield, say	6	19	6
Total outlay on plantation up to the fourth or fifth year	£30	0	0

As to the returns from the plantation, the earliest crop of bark may be yielded by thinnings or uprooting of weakly trees at the end of the fourth year. Taking these at 25 per cent. of trees planted, and yielding six ounces of bark per tree, we have, say 330 lbs. of bark at 3s. per lb. (less 10d. per lb. cost of barking, drying, shipping, and broker's expenses), yielding a net return of say £35 per acre. This, it will be noticed, will more than cover expenses of the plantation up to the end of the fourth or fifth year. There will then be left some 2,400 trees to the acre, well established, and capable of yielding regular crops of bark, at the rate of £30 to £60 per acre, up to the time when the whole plantation is cropped.

The total yield of the plantations (deducting cost of barking, curing, and shipping expenses, up to the end of the ninth year) will probably be not less than £175 per acre, against a total outlay for planting operations for that period of about £40 to £45 per acre. The estimates in all these cases are based on that price of Creole labour as at present existing in Jamaica, viz:—Men 1s. to 1s. 3d. per day; women 9d. to 1s. per day. The weeding is entirely *by hand*, done mostly by children and women at rates varying from 4½d. to 9d. per day.

General Notes.

Society of Telegraph Engineers.—The annual meeting of the Society of Telegraph Engineers and of Electricians was held on Thursday, 15th inst., when the Council for the ensuing year were elected, the President being Lieut.-Col. C. E. Webber, R.E., a member of the Council of the Society of Arts.

Oriental Art Exhibition at Glasgow.—A meeting was held on the 19th inst., at Glasgow, under the chairmanship of the Lord Provost, to open the Oriental Art Loan Exhibition in the Corporation Galleries in Sauchiehall-street. Sir Philip Cunliffe-Owen, K.C.M.G., C.B., alluding to the part taken in this Exhibition by the South Kensington Museum, said that the objects purchased with the nation's money, were not intended for Londoners only, but to be spread broadcast over the United Kingdom. So rapidly was that system of circulation increasing, that, within the last nine months, they had contributed loans to double the number of Exhibitions that had been so assisted during the same period last year. Within the last 20 years, 250,000 objects have been sent from the museum to 250 localities. These exhibits have been valued at two milions sterling, and they have been visited and examined by ten millions of people in the large centres of manufactures.

National Exhibition at Turin.—A meeting has been held at Turin for promoting the scheme of a National Exhibition, which it is proposed to hold in that city in 1884.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The first of these lectures on the "Recent Wonders of Electricity" was delivered by Mr. W. H. PREECE, F.R.S., on Wednesday, 28th inst. Various experiments were performed in illustration of the points raised in the lecture. Wheatstone's telegraph apparatus, Gower telephones, electric railway signalling apparatus, electric bells, electric indicators, fire and burglar alarms, &c., were exhibited. The room was lighted by means of Edison's incandescent light from branches on the wall, and from an ornamental chandelier exhibited by Messrs. B. Verity and Sons. The lamps were worked by means of an Edison dynamo-machine, and this was driven by a six-horse power steam-engine, lent for the purpose by Messrs. Robey.

Proceedings of the Society.

PATENT-LAW AMENDMENT BILL.

The discussion on this Bill was resumed on Thursday evening, the 22nd inst.; Sir FREDERICK BRAMWELL, F.R.S., in the chair.

Mr. EDMUND G. GAYER said they heard a great deal in the present day of the alleged superior inventive faculty of Americans over Englishmen, but he believed the chief reason for this might be found in the fact of the extreme cheapness with which patents were granted in America; and he felt great sympathy with those speakers who had attacked the schedule of fees in the present Bill. It perhaps might not be possible to grant patents as cheaply here as in America, though he failed to see why; at any rate, the fees named seemed to be greatly in excess of what was necessary to support an effective Patent-office, which in the opinion of many persons—and certainly of the late Sir Antonio Brady—was all that ought to be aimed at. He suggested, therefore, that there should be some small fee of one or two guineas per annum, with power to the patentee to stop the payments at any time he might think fit during the period granted, if he found the patent unremunerative. If the fees were reduced, no doubt the number of applicants would be very much greater; but even though a larger staff would be required, he thought a lower scale would still pay the necessary expenses. He agreed with a former speaker that the fifth clause was wholly bad. If it were thought too curt to simply say the subject-matter should be "any new invention," he should suggest a clause which was adopted at the Paris Congress, as to what was patentable, which was in these words, "That which is patentable shall be all inventions either of procedure or of products, except financial combinations or inventions contrary to public order and morality." The remainder of the clause as it stood in the Paris Congress, was, perhaps, not so much required in this country, because it related to patent medicines, which hitherto had not been patentable in France. The clause, as it now stood, was so wide that it almost amounted to the ludicrous. For instance, in the third sub-section the words were, "Any process or method of producing any manufacture, product, or result." It was perfectly obvious that that would enable a patent to be taken out for almost anything conceivable; one might take out a patent for a mode of getting food to the mouth by the aid of a spoon, or lifting furniture from one side of the room to another. In the fourth sub-section of section 12, and the last sub-section of section 15, the clause as to endorsing specifications with certificates of having been refused, not having been considered a proper subject for a patent, appeared to him very objectionable. An invention would thus be labelled "stinking fish," without the novelty of ever having satisfactorily been looked into. Dr. Siemens said a patentee going to the office at present laboured under a great disadvantage, because he did not know the contents of existing specifications; and he thought it desirable that there should be some system of examination, so as to test novelty. That was a sentiment with which, no doubt, many concurred; but there was no provision in the Bill for carrying out anything of the kind. The sort of examination proposed was very wide, and would almost amount to a protracted litigation in many cases, before a patent could be granted at all. He would suggest the omission of those words at the end of sub-section 4, section 12: "But in that event every patent, and every copy of the patent, if granted, and every office-copy of the specification, shall be endorsed with, and bear on it, a short statement of the report of the examiners;" and the similar words at the end of the 15th section. He would also suggest that after clause *b*, of section 15th, there should be inserted another to this effect: "Whether the application be wanting in novelty, regard being had solely to prior publications existing in the Patent-office." At the Paris Congress there was a clause, generally approved, to the effect that one of the necessary inquiries before granting a patent should be whether the invention was wanting in novelty, regard being had solely to prior publications in the Patent-office; that no adverse report of the examiner should preclude a patentee obtaining a patent at his own cost and risk, and that reports containing the opinion of the patent officials should not be made public. He was not quite certain about that; but that a right should be given to the applicant of amending his specification, by inserting a reference to matters discovered by the authorities to be amongst existing specifications, and which appeared to conflict with his application. It was an immense disadvantage to intending patentees, that when they went to the Patent-office, they had not the remotest notion of what the contents of existing specifications might be, and quite unintentionally, they might trespass on the subject-matter of an existing patent. It had also been suggested that amongst the species of fraud which should be rendered punishable, ought to be any fraud on the part of the applicant, and that it should be a good ground for refusing a patent, and with that suggestion he agreed. He did not know why clause 26, referring to stamp duties, was introduced, and he thought it would be rather more convenient if alterations in stamp duties made in any year, should be included in the Customs and Inland Revenue Act. Allusion had already been made to the enormous power proposed to be conferred on the new Commissioners, of making rules and orders, which he thought it would be quite impossible for them to carry out; but as the second part of the Bill had been so fully dealt with already, he would not detain the meeting with any further observations upon it.

Mr. ERNEST CARPMAEL had listened to the discussion with a great deal of interest, and desired to speak on two points only. First, the proposed change in the Court, and the second in the proposed change in the law itself. There seemed a pretty general admission that the framers of this Bill were perfectly justified in bringing forward some Bill on the ground that a change in both these respects was required. Mr. Justice Stephen, who made the strongest onslaught against the tribunal proposed, did not maintain for a moment that the existing haphazard system of trying, or refusing to try, patent cases was at all satisfactory; in fact, he himself proposed a new tribunal, namely, a Judge who should be specially chosen by the other Judges for his competency to deal with matters relating to patents or other scientific questions, and who should be assisted by assessors. Such a Court would no doubt be a great improvement on the existing Court, but there was one point with regard to it which deserved notice, namely, that there was no method suggested in which these assessors would be paid. If they had to be paid by the parties, it would increase the cost of the tribunal very much indeed. With regard to the Courts specially appointing a particular Judge, not only from his legal acumen, but his general scientific knowledge—and he took it that was what Mr. Justice Stephen meant when he suggested that a Judge should be specially chosen—he thought himself there would be a great risk in a Court so constituted that the assessors might act the part of mere lay figures, and have very little voice in the case; in which event the Court would not be a satisfactory one. It seemed to him that a much better Court would be to choose two eminent scientific men (it ought not to be limited to engineers and chemists) to sit with the Judge, to be presided over by a Judge specially chosen, but to have an equal voice with him in the result. That would be, practically speaking, as good a Court as could be. You could not combine in one man knowledge of all sorts, or at any rate, you could not ensure having a Judge thoroughly trained in scientific as well as in legal subjects; therefore you ought to combine the knowledge in the Court itself, and have scientific men and a Judge. He knew he was speaking what sounded heresy to a great many members of his own profession, because they held that, to qualify a person to occupy the position of a Judge, all you wanted was legal training, that he could pick up knowledge of the particular questions before him by a sort of cramming process in a moment, and apply his legal knowledge to the information so crammed so as to give a satisfactory result. That seemed to him to be a fallacy altogether, and perhaps the best way of showing the fallaciousness of it would be to give an extreme case. Who would choose a mathematical man who knew nothing of the Greek alphabet, even if he were assisted by having called before him all the Greek scholars in the kingdom, to decide a question of Greek grammar or of precise force and weight of a Greek particle; or who would choose a classical man ignorant of the laws of motion, and possibly of the elements of the differential calculus, even if he had the most thorough legal training, and were gifted with the fluency of Mr. Gladstone himself, to decide a moot point in the lunar theory, even although he might call all the astronomers of Europe before him? These seemed extreme instances, and they appeared at once absurd, because one realised at once, that it was impossible to cram these subjects in one or two hours; but really the same thing held good in matters of science, and even in mechanical matters. Many people thought they knew all about mechanics, and were quite competent to deal with any question about a machine off hand; but he ventured to say, there was as much to be learned in mechanics, he was going to say as in law, but as much as in a good many other subjects, at any rate. This being so, a man was very likely to make a mistake and to go egregiously wrong, simply because he thought he knew all about it, when, in fact, he did not. Justice ought to be cheap, and that was one of the points in which the present system failed. It was not fair for the advocates of the present system to bring forward the fact that there were only nine patent cases tried in the year, and from that to argue that the interests involved were comparatively trivial, and did not justify any great change being made. That was really bringing forward one of the evil results of the present system as the reason for not changing it, because people would rather put up with wrongs, than run the risks of a legal decision. At the present moment, in Ireland, there were a good many landlords who did not bring claims for rents in the law courts, but that did not prove that the law courts were acting as well as could be desired. Supposing the result of patent litigation should be even more dubious than at present, and the costs trebled, what would be the result; instead of nine cases a year, you would have two or three, and continuing the same course, there would be none at all; but that would be no proof of the excellence of the present system, but a conclusive proof of the badness of it. There ought to be a competent Court, which ought to give cheap justice, and for that reason, there ought to be some rules which would limit the amount of costs to be recovered by a successful litigant. In most patent cases, the question turned on, possibly, two questions: Was the invention described in specification *a* a new one, and was invention *b* an infringement of that described in specification *a*. It seemed to him, that a man who wished to use an invention described in specification *b*, ought to be able to submit that dry question to the Court, and get a decision upon it, knowing the limit of cost he would incur. He ought, if he liked, to be able to argue it with counsel, and be able to call expert witnesses; but he would make those luxuries which he would have to pay for himself. With regard to the change in the law, he cordially agreed with everything Mr. Justice Stephen had said in support of the first part of the Bill. He thought the definition of subject-matter was rather a dangerous one, and had better be left on the existing definition of the statute of James—"any manner of new manufacture." With regard to section 23—"the power of re-defining and amending"—at present a patentee could only disclaim or cut out of the specification some claim already in it; and the result was that great injustice was often done by reason of a patentee having unfortunately worded a claim, or often by a narrow and technical construction being put on the words he had used. The inventor thus lost the advantage of what was undoubtedly a new and useful invention, which undoubtedly had been infringed, but the infringer managed to escape out of the precise wording used in the claim. It was a very important thing for an inventor to be able to come to the Court and say, "When I drew this specification the invention was young, and had not been developed. I did not know exactly what had gone before. I or my patent agent, through ignorance, did word the claim as it ought to be worded; I wish to re-define my invention." It seemed to him a man ought to be perfectly at liberty so to re-define an invention; but that was a most dangerous power to commit to the inventor, unless supervised by a perfectly competent Court. For that reason alone these Commissioners ought to be men of eminence and high standing, otherwise this provision would be so dangerous to the community that it had better not to be introduced. The only other remark he would make was with regard to section 23, sub-section 3, where it was provided that the Commissioners should grant the request on being satisfied the amendment would not make the specification embrace any invention which could not originally have been contained in it, provided always that amendment by way of further claim should not prejudice the rights of persons already practising the invention. What did the authors mean by prejudicing the rights? Did they, by that section, mean to give the man who had been infringing—who had seen the loophole in the specification and had evaded it—the right for all the rest of the term to use that invention for nothing? If they did, it seemed to him it was most unjust. He could understand that they ought to give the infringer for his ingenuity leave to infringe until the specification was amended, but afterwards he could not see any reason why that man should be allowed to infringe any more than anybody else.

Admiral SELWYN wished particularly to recognise the fact that the principle of such a law as this was surrounded with difficulties. He had seen that with five successive Bills drawn by all the legal authorities of the land introduced into Parliament and rejected by Parliament on each occasion. The only Bill which had been well received by the House was that brought forward by Mr. Brown, Mr. Anderson, and Mr. Broadhurst, which contained but one clause, but that attacked the central features of the whole thing. It recognised the truth that this was not an inventor's question. He could not claim, as some gentlemen had, an hereditary interest in this question, but he had attended to it closely for the last 25 years, and he knew the day when the country began to understand that this was not an inventor's question at all, they would approach the Bill from the right standpoint and come to a right conclusion. Still more was that the case with that Society, a society devoted entirely to the promotion of arts, manufactures, and commerce. That being so, it must be devoted to the encouragement of invention in order that those manufactures and arts might be improved, and that consequently commerce might be set on foot which would profit the nation. It would be lamentable indeed if the Society of Arts were to accept any clause in a Bill which was not for the benefit of the nation or the arts and manufactures. It was all very well to say, "Oh, the House of Commons will never listen to a Bill which cut down fees," but he wanted to know whether cutting down fees would increase the income of the nation. If they once obtained conclusive evidence, which anyone could get from any successful patentee, that the Income-tax paid by the persons who profited by the successful invention was ten times more than all the fees paid in one year for patents, that was conclusive evidence that the thing affected the national prosperity. To say that they would not cut down the fees to what the Americans charged, because the House of Commons would not stand it, was to surrender a principle, and the Society of Arts ought to be the last to surrender any principle of that kind. He recognised with the greatest pleasure the preamble of the Bill, which he thought one of the finest ever drawn, and it affirmed this very principle of which he had been speaking. At the same time he must take exception to the words—new and meritorious. It appeared as if anybody could know what was new and meritorious. But how could you know it? All you could know was that it had not received publication before. They all recollected a good many things, such as gas, the Atlantic cable, steam-ships, everyone of which was decried when it first appeared, and was said not only to be not novel, but not even useful.

The CHAIRMAN observed that the preamble said it was desirable that new and meritorious inventions should receive assistance. They could all agree to that, and not desire that those that were not new and not meritorious should receive assistance.

Admiral SELWYN said that seemed to point to some future investigation of what was new and meritorious.

The CHAIRMAN said page 2 line 6 showed what was an invention. A patent might be granted for an alleged invention.

Admiral SELWYN said he knew what the practice had been under all previous Bills, and he understood what it would be under this Bill. On the second page it said an invention was deemed new if not published within the United Kingdom, &c., for 30 years. Now the Committee of the Association for the Reform and Codification of the Laws of Nations recommended 23 years, because they recommended at the same time 21 years' patents; and they said, in view of that fact, that an enormous number of most valuable inventions now lay useless as provisional specifications only, not being proceeded with as patents. It would be desirable that those should again fall into the domain of the public, but that they should not be left without a father, but that they should fall into the domain of the pseudo-parentage which brought them forward and made them valuable. They considered that if you gave a patent 21 years, it was just that a short time should elapse during which it should remain in the public domain, but if it was not taken up, then it should be free for someone else to take it up, and develop it. He therefore suggested that thirty years was not a good term, unless they proposed to give to all patents the prolongation. They gave 17 years and did not go as far as 21, which had been recommended by very large and influential bodies as a fair time during which a patent might be made valuable. In using those words "made valuable," he never considered how valuable it might be to the inventor, but simply its value to the public; that was the true view to take of it. Again, it was quite clear that if the issue of a new edition of a book would prejudice a patent, people would take care that there was a new edition issued shortly before they proposed to attack somebody's patent, and then that would destroy the whole value of the clause. If anybody wanted to attack somebody's patent, he would go and buy up an old publication, and cause a small cheap edition to be issued, which would render the patent void. He thought, therefore, that clause would be of very little value. It had been rightly said that the Paris Congress came to the conclusion that patents should be granted for something more than the statute of James gave; that was because nobody could tell what it meant. They tried, in the best way they could, to define this, but it was not easy. There were many cases where a chemical product could be made by new means; the product was not new, but the process was; and it could be made more cheaply, and, therefore, they said it was wise to give a patent for such a process. It must not be supposed that all these conclusions were arrived at without a great deal of thought. The Conference was largely attended by delegates from nearly all countries, and he had the honour of being appointed a vice-president. One aim was to do something towards an International Law of Patents, which was what all hoped for, and what any Bill which was drawn ought to keep in view. In clause 7 page 3, he objected to the limit of 12 months, because it would have the effect of preventing a good useful invention coming to this country. An American inventor took out a patent, and as he found it answer, he gradually was induced to take out foreign patents, and, in the course of his experience and state of his profits, he might find it advisable to take out a patent in England. Why should he not do so? It might be as unknown as half the useful inventions he had seen in America were to-day, because it was nobody's interest to bring them over, therefore he would not prevent the possibility at any time of the foreign inventor bringing his invention over here and patenting it. He must either do that, or as formerly, allow anybody else to bring it over and make it valuable here. In the next paragraph there was a reference to circulation or re-publication within twelve months; but he would draw attention to the fact that they had given to exhibitions a protection for eighteen months, so that it was quite clear they would make it the interest of every patentee to go, and get up an exhibition or attend an exhibition in order to get the eighteen months protection instead of the twelve which he would otherwise get. In his opinion there ought to be no prolongation whatever. They were now given to a successful few of those who could afford them, but they were refused to the toiling many, and that ought not to be, either in the interests of the inventor or in the interests of the capitalist or the public. The capitalist added, if you tell me I am going to have the patent for a definite term of 21 years, I can put up any amount of machinery to introduce this cheaply and well; it will pay me to do so, and place the article on the market. If, on the other hand, it is uncertain whether I get a prolongation or not, my interest in doing so is no longer the same. I cannot afford to spend capital on it, and supply the public cheaply. The question here again was not the question of the inventor, but of the capitalist and the nation. Where capital could be invested profitably, industry is created, and the nation must profit. He hoped, therefore, the framers of the Bill would give their attention to the question of prolongation as against a fixed term of twenty-one years. With regard to the payments, he stood almost alone in advocating a single payment as in the United States. Some people said annual payments weeded out the useless patents, but they destroyed a good many useful ones, and he had yet to learn they ever weeded out a useless one. A patent which was not useful went of itself if there was no market for it, and ceased to exist, not because the man could not make the payments. What, then, was the other reason for these periodical payments—to get a little more tax out of the inventor, and to put year by year a little more tax on what he always called the seed corn of industry; to prevent a working man as much as possible from using his brains. To the working man the annual payment was a serious matter. He might get a friend to advance the small amount necessary for a single payment, but friends, unfortunately, did not stick by you year by year. The provision for giving to the Government or its officers power to take patents, on terms which were to be settled by the Commissioners after hearing the representatives of the Crown and patentee if desirous respectively of being heard, seemed to him unsatisfactory. The Crown in this case might say, "I do not want to be heard at all; I intend to take it."

The CHAIRMAN said the intention of the clause was, that either one of the two should be able to appeal to the Commissioners.

Mr. A. CARPMAEL thought the result would be, if the Crown did not desire to be heard, the Commissioners would judge it in absence of the Crown.

Admiral SELWYN said he did not think the words were very happily chosen, at any rate, he was going to attack the clause on another ground. If you put inventions which might benefit the State under any other condition than general inventions, which benefited the public, you disinclined inventors to deal with those matters which might benefit the State. That had always been the case. These exceptions from a general rule were not for the benefit of the nation. They might seem to be so by some penny-wise and pound-foolish persons, who wished to appropriate an invention at less than the market value for the Crown, under the plea that it was for the good of the State, but it was not good and never could be. Then as to these compulsory licenses. Imagine a poor inventor, who was not able to get his invention at once adopted, brought up on the plea that he was not able to supply the public immediately, what sort of property would that be for him to go to a capitalist with? The capitalist would say, "I have not the capital just now; I am willing to undertake it, but I cannot do so at once. If there is any plea brought forward of this kind I cannot touch it all, it makes it too uncertain altogether." These things might be brought forward vexatiously. Who was to decide that you were not doing enough? You ought to be the best judge of that. When you bred horses, you would breed as many as would sell, not as many as the pasture would hold. If a man had any property at all, he must not be boycotted out of it. Then, passing many other things, he came to the case of revocation of patents, which again was objectionable. It was like the Irish Land Bill. It made property uncertain, and, therefore, less valuable: the more revocable a patent was the less property it was, and the less people would be inclined to have to do with it. One ground for revocation was that the specification was insufficient or misleading. If so, that was mainly the fault of those who examined the specification. This was the duty of the Government. It was carried out in the United States without any difficulty whatever, and he could bring before them the testimony of an ex-Commissioner of Washington who had closely examined all these points. They examined the specification, and told you, if there was anything in the Patent-office which would invalidate it:—"Don't bring it to us until you have cleaned that off." If the examiner had not done his duty, and passed the patent, was it not very hard to revoke the patent for his fault, and deprive the capitalists of his interest in it? Passing over the question of the prolongation of patents and exhibitions—as he had already dealt with those points—he thought it most desirable that the provisional specification should be continued, and that the utmost time, consistent with public convenience, should be given, for a reason which nobody seemed to be remembered, which was this. When he invented something, it might be a cartridge; he did not make it with his fingers; he had to go to a manufacturer to find out how the thing could be done. He knew it would answer, if the thing was done; and in his own case, having invented a military cartridge, he had to go to Messrs. Ludlow, Birmingham, and although he was told at first that no cartridge could be made except by spinning, he soon persuaded Messrs. Ludlow to make one by pressing it up as they pressed up caps. He could not do it himself, and if he had not got provisional protection, he should have been at the mercy of the first man in their workshop who chose to go and take out a patent. He thought that to require that the provisional and complete specifications should be identical, rendered the provisional specification of no value whatever. The Commissioners were to have full power of making rules, so that they might, at any moment, require that the provisional should be co-incident and co-terminous with the complete specification. It had been done, and, therefore, he must assume it would be done, unless very wise rules were made to the contrary. So long as they had thoroughly good Commissioners, imbued with the spirit of the Act, they would never do it, but it was left open to be done, and, therefore, he would insert words to say that no more details should be required in the provisional specification than an outline of the invention, and there should be no violation of the primary simplicity of the Bill without Parliamentary sanction. It was true that Parliamentary sanction was required afterwards for any alteration of the rules, but Parliamentary sanction when required, was so commonly given, and required such close watching, that a great many things might pass which would not be approved of afterwards. The Commissioners were also supposed, in questions of infringement, to decide all questions of law and fact. Was it possible that an engineer without any legal assistance could undertake to decide all questions of law? Here he must advert to a great mistake which seemed to be made commonly enough. At a meeting of an institute in Whitehall-yard, when Mr. Vernon Harcourt, as he was then, was present, they were told there was a legal dictum to the effect that there was an enormous difference between the legal mind and the judicial mind; that while the judicial mind was always occupied in the endeavour to eliminate error from truth, the legal mind was always occupied in the endeavour to make error look like truth. That being so, what they really wanted was the judicial mind, not the legal mind at all. He should have much more confidence in Commissioners appointed by the Crown, of high standing, of high judicial attainments, than in any other body whatever. He should be sorry to be an expert to assist a Judge—luckily he was not supposed to be an expert in anything but nautical affairs, but he should be sorry to be called on nautical affairs—to judge of all that could be done in the way of navigation. He should expect an inventor to come before him sooner or later with a ship that would go under water altogether, and never come above the surface until she reached her destination. He would most likely say, "This is not the way I used to do it; I do not know anything about it, and if I do not, it cannot be of any value." He need not say anything about the pleas which were to be allowed. It was not his business, and what Mr. Justice Stephen had said was quite sufficient. As to a patent bearing on it the statement that the examiners had rejected it, he thought no such statement ever ought to be on a patent. The business of the examiners or their clerk, was to be the friend of the inventor in the interest of the State, and to cut away all difficulty he could see his way out of, and he ought never to make any report until he himself was thoroughly satisfied the patent was as good as could be made, and did not interfere with any existing patent in the archives of the Patent-office in that particular thing. People might say that could not be done, but the United States always did it. He asked the ex-Commissioner how it worked, and he said things went in grooves, sometimes sewing-machines, sometimes steam-engines, and sometimes something else, but they found they could devote a certain staff to one subject, and that staff met the difficulty, and practically everyone went away thoroughly satisfied that their patent did not infringe any known patent previously existing in the same subject. As he had already said, the fees were the central point of the question. There had always been an excess of fees over the expenditure in America, and there was no reason why it should not be so. With regard to the prolongation, he presumed it was not intended that a patent should exist for 28 years in all.

The CHAIRMAN said certainly it was. This was the possible limit under the present Act.

Admiral SELWYN thought that was totally wrong in principle. The provision which allowed a representative of the Crown to oppose prolongation was an advance in the wrong direction. The result would certainly be, if a patentee had a patent which the Crown seized upon for some fancy reason, that he would immediately go abroad, and the foreign Government would profit by exactly the very thing which ought to be used here. He was sorry he could not give more praise to this Bill, but hoped he should be able to do so before it was finally settled. He was quite sure what had been said would lead the framers of the Bill to feel that there was something yet to be done, and some opinion to be consulted, and in conclusion he would now read the questions he had put to the ex-Commissioner of the United States Patent-office, and the answers which he gave:—*Q.* How has the system of examination worked in the United States Patent-office?—*A.* Examination useful and easily practicable, only objection being that good men are liable to change at the end of four years; still, the position is much sought after. *Q.* How many Examiners, and what are the branches?—*A.* Not aware how many now employed. One division occupied with sewing machines alone, subdivisions of labour being found advantageous. Examination prevents litigation, and is not attended with any difficulty. *Q.* How is a patent limited as to subject?—*A.* Not more than in England. All the separate parts of a machine can be included under one patent, but if desired, a separate patent of application can be taken for any particular part in its use for other machines. *Q.* What is the experience of models?—*A.* Only to be required when in the opinion of Commissioners absolutely requisite to explain invention. Invariable requirement generally regarded as a nuisance, and about to be done away with. *Q.* Is it the case that so-called "worthless" patents are encouraged by low fees or the reverse?—*A.* As much as 15,000 dols. paid to skilled inventors per annum who are retained by firms. No worthless patents are allowed to pass examination, if by that term is meant "infringing" patents. If it be merely the value of the patent when acquired that is in question, every patent has its value, if in any manner it is brought into use, or noticed in any way. *Q.* Have the fees always left a sufficient margin over expenses?—*A.* Always more than sufficient. *Q.* What is the practice as to caveat?—*A.* It is a provisional protection in most of its features, lasting one year. *Q.* How are patents litigated when conflicting or anticipated?—*A.* Interference is declared, both parties are notified. First tried before Commissioner, with appeal to ordinary Courts. Right of appeal if applicant is not satisfied with Court's decision, to Supreme Court or Congress. *Q.* Is the term of 17 years, without prolongation, satisfactory?—*A.* A single term, even of 21 years, is preferable. America, in spite of high wages, produces more, with less labour-cost, than any other country. *Q.* Have inventions and industry been fostered by the existing practice?—*A.* Most certainly. He hoped all he had said would be considered to be advanced in a spirit of fair criticism, and not in anything like a captious spirit.

Mr. CAMPIN coincided with what the Admiral had said, and thought they would all be willing to admit that, in many points, he had shown matters which were to be considered in the final development of this Bill. If they were to do any good with this Patent Bill, they must make the cost of obtaining patents as cheap as possible; and he was quite sure, from what they had heard, they could not fail in getting enough money to deal with all other matters. Mr. Justice Stephen had made some observations about the peculiar kind of Court which was put in the Bill, but to object that a Court of that kind could not deal with everything did not seem to him conclusive. It was the same with the Probate Court and the Admiralty Court. He himself did not altogether approve of it, nor did he approve of the idea of upsetting the jury system, and putting a single despot in place of that system which had now gone on for ages.

Mr. ALEXANDER said a great deal he had to say had been already anticipated, but having gone through the Bill carefully many times, he felt they were deeply indebted to the Society for a great deal of valuable matter which it contained. He entirely agreed with the criticisms of Mr. Justice Stephen as to the separate Court. The last speaker had drawn a parallel between a separate Court for patent litigation and the Admiralty Court, but he thought that parallel failed, because in the Admiralty Court the Judge decided the points of law, and had assessors by him to whom he could appeal and ask whether under such and such circumstances, judging by their experience of navigation, the captain had taken the right course. He did not see any analogy between that and patent cases. He had paid a good deal of attention to several patent cases, and he could not see that there was any great generic differences between the questions which arose in those cases and any others. Judges of the Courts had constantly to apply their minds to unusual states of fact, they had often to learn details of a business of which, perhaps, they had never heard before, and he did not think there was really more difficulty in patent cases. A man without having more than a general good education, and the qualities which went to form a good Judge, could, assisted by good expert evidence, go into the merits of a patent case, and he did not believe that a better Court could be found than a good Judge. If the case happened to come before a weak Judge, he very likely decided wrong in that just as he would in any other case, and he believed the complaints made were because the case happened to go before a weak Judge. It seemed to him that there was only one way by which you could satisfactorily meet the objections which were so powerfully urged at the commencement of the last meeting in the interest of the poor inventor. The working man had not money, no doubt. It was difficult for him to pay £12 10s. at once on the strength of an invention which was hardly perfected. The only way to meet the objection was by a system of annual payments. He would say let there be only 50s. the first year, 10s. on application and £2 on the specification; then 50s. a year for the first five years; then £5 a year for the next five years; and then £7 a year for the next seven years: that added up would come to about £90, whereas the amount in the present Bill was £102 10s. That was only the general idea, but that was the sort of principle you must adopt if you were really to fairly meet the just demands of the working man on the principle of making success pay. There was no reason why the inventor should be taxed more than other people. All he ought to be called upon to do was to pay the expenses of the Patent-office; and if by graduating the fees in that sort of way you could make the successful patentee pay a very large share, and not burden the poor struggling beginner too much, you could hope, on the average, to make the Patent-office pay itself, that was the right principle to adopt. Other details he would not stay to go into, but one blot he thought would be the multiplicity of appeals at early stages. In section 12 there was a reference to an examiner, who should report on two points only: whether the invention was subject-matter for a patent, and whether the title sufficiently indicated its nature, and was in accordance with the provisional specification. The question of novelty was omitted, the very thing Dr. Siemens spoke of as being the *raison d'être* of the examination. He did not see much use in having an examination if you did not include novelty. You would still have what Dr. Siemens complained of, one patentee going one day with his invention, and another going the next and having protection granted for the same thing. Then at this stage the examiners first reported, then there was an appeal to the Commissioners on that, and at the further stage of the complete specification there was to be a report on those two points, whether the complete specification was in accordance with the title and with the provisional specification; and, secondly, whether the claim of the applicant was defined with sufficient clearness. On that, again, there was an appeal; and, thirdly, as to any question of fraud, there was an opportunity for litigation on that, so that he thought a poor patentee had the prospect of most serious obstacles in his way. He thought the title might require to be amended in the interests of the public, but that there should not be any appeal; the Examiners might be entrusted with absolute discretion on that point. With regard to everything else, he did not think anything ought to be required; certainly no endorsement should be put on a specification, excepting that a patentee might be obliged to refer to previous specifications so as to prevent his being misleading, and injuring those who came after him. He might be required to do that without injuring him, and nobody would know whether he made the reference of his own accord, or whether it was forced on him by the examiners, and there again there should be no appeal. In this way he would dispense with all appeals and oppositions, except the examination, which should be an advisory examination for the benefit of the inventor, and of course the opposition on the ground of fraud ought to be enlarged as had been suggested.

Mr. H. **TRUEMAN WOOD** (the Secretary) said he was reluctant to trouble the meeting with any remarks, because he knew he should have a full opportunity of laying what he might have to suggest before the Committee, but there were one or two points on which he was glad to have an opportunity of saying a word or two. First of all, with regard to subject-matter. The Committee spent a good deal of time and trouble over the definition—in fact, there were very few things on which more thought was spent; but when that unhappy definition came before the meeting, nobody had a kind word to say for it, they all preferred to go back to the old definition of the Statute of James, simply because, as far as he could understand, it did not mean anything at all. You might just as well say a patent should be granted for any article which had been hitherto deemed patentable, or might hereafter be so deemed. That was a very conveniently-wide definition, but, after all, did it work well in practice? It might work very well when the patent came into a Court of Law, because then the thing was thoroughly thrashed out by the aid of counsel, expert witnesses, and a Judge; but you had to deal with subject-matter before it got into a Court of Law at all. You had a law officer—or rather a law officer's clerk—dealing with it, and there were many cases in which useful patents had been refused by the law officer's clerk, because he did not think they were subject matter, and from him there was no appeal. One did not often have the opportunity of hearing of cases in which patents had been refused on the ground of subject-matter; but he remembered the late Mr. William Newton telling him, a year or two ago, of one case, which was an invention for hats, in which the then Attorney-General refused the patent on the ground that it was not subject-matter. The applicant took that invention over to America and patented it there, and it was profitable. That showed, at all events, there was a public need for it, and that protection ought to have been granted. One or two other instances he would not trouble the meeting with, but he had had an opportunity of noticing what very funny things some law officers considered subject-matter. He came across a patent the other day for making match boxes; the patentee proposed to make them by the novel process of taking a sheet of thin paper, folding up the different edges, and glueing the corners together; that "was a new manufacture within this realm," or else he would not have had a patent for it. If one could get a patent for a thing like that, he did not know what ought not to be subject-matter. With regard to examinations, it had been his business to make analyses of a great many patent specifications, and what struck him most was the hopelessly bad way in which the majority were drawn. When you got one drawn up by certain well-known patent-agents, nothing could be clearer or better; but when you got them drawn up by the inventor himself, or by an agent who had not had very much experience, it was quite the reverse. After a little practice, you could often see the inventor was groping about, trying to explain what he had in his head, and you could see it through the specification, but at the same time he really did not describe it. The object of this Bill was that examiners who would have experience—and perhaps it would be possible to find men who would not be so very thick-headed as it was suggested they would be—should assist the patentee, and say to him, "You really must describe this a little better; take it back and clear it up, and bring it again, and then you shall get your patent." Of course everything depended on getting good men, and paying them sufficiently. When Admiral Selwyn was speaking about what the American Commissioner had told him, it did occur to him that all the American examiners were not quite so successful in their work; or rather, it was not that they were not successful, but that they could not be kept at their work. Five or six years ago, in the report of the United States Commissioner, it was said that as soon as the Examiner really got to know his work, he was paid so badly that he went away and set up as a patent agent himself, and consequently they did not get so good examiners as they otherwise should.*

Admiral **SELWYN** said the ex-Commissioner told him the reason of their losing the Examiners, was the change of all occupants of offices every four years.

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* The statement referred to, is contained in the following extract from the Annual Report of the Commissioner of Patents for the United States, for the year 1874. Published in the *Commissioners of Patents' Journal*, of 5th March, 1875, No. 2,209:—"It is to be regretted that the most efficient and competent men cannot be retained in the office. When they become thoroughly familiar with their duties, and efficient in the performance of them, their services will command a much more liberal compensation outside than in the office. The result is, that some of the best examiners are led to resign their positions for the purpose of entering more lucrative employment, where their experience in the Patent-office becomes available." H. T. W.

Mr. WOOD said of course that operated in the Patent-office as well as elsewhere, and was an inherent defect in the American system of government; but, on the other hand, there was the definite statement in the report of the United States Commissioner, that he could not keep the Examiners, because it paid them better to go away. There was one other point which really had not much to do with the Bill, but it had formed the main subject of one or two gentlemen's remarks, viz., how many inventions were really made by working-men? He was very reluctant to say anything which would seem to cast a slur on working-men, which he did not in the least desire to do, but he doubted the statements so often made, as to the majority of inventions being made by working-men. To test the fact, he had looked through the first 400 applications for patents in the Commissioners' *Journal* for 1879; of those he found there were 120 in which the applicants' trade, business, or profession was not described in any way; 123 in which the description was such that by no possibility could they have been working-men. In 6, the applicant was described as a machinist, sawyer, or something showing he was a working man. In 35, the description was indefinite, the applicant being described as an engineer or brass founder, or something similar, when, of course, he might be a working engineer, or he might be the President of the Institution of Civil Engineers; and, besides those, to make up the 400, there were 116 communications from abroad. Of course, one did not know who the real inventors were; but there had been a good deal of talk, with no evidence whatever; and this was at least one fact, that out of those 400 applicants, there were only six unquestionable working-men inventors.

MR. WENTWORTH SCOTT said the points in relation to fees had been treated from almost opposite points of view, his own opinion being, as a poor inventor, that no Bill would be satisfactory which in the first instance made the fees quite so high as at present. It was a point which was worth the consideration of the Committee, whether they intended this Bill to act as a kind of "sop to Cerberus" and a step forward, or whether they wished little matters to be settled on tolerably firm grounds for some time to come. If so, he would urge that the fees be reduced to at least one-half. He did not think the provisional specification should cost more than one guinea, or something like it. If it could be found that the whole of the patent would not cost more than about £50, it would be satisfactory to the inhabitants of the country at large—dividing those payments in such an easy manner, and gradually going up according to the assets of the inventor, but still commencing with a comparatively small sum. Dr. Siemens had pointed out that patents were intended for several classes of people—the manufacturer, the inventor, the public at large, and the lawyers; but he must dissent from that view; he did not see why lawyers should be considered at all; they had plenty of pickings elsewhere, and he did not think any Patent Bill should be drawn up with any special reference to them. With regard to the appointment of the Commissioners, he agreed with those who preferred a judicial head in all matters relating to patents, because neither a chemist nor an engineer would be capable of dealing with all cases. Many patent cases would require a botanist to sit upon them; but if they had a Judge selected for his superior ability, with power to call in expert assistance, he thought that would meet all the necessities of the case.

The CHAIRMAN said that during the progress of this discussion, it had occurred to him to wonder how many of the speakers had ever tried their hands at drawing a Patent Bill. The position of author and that of critic had often been commented on, and it was very commonly believed that the position of critic was much more easy than that of author; but if that were true with ordinary work, still more so would it be with regard to a Patent Bill. He trusted that, before the Committee met again, he should have an opportunity of tabulating the opinions expressed by the different speakers here, and of showing how entirely opposed they were in many points. There were certain points on which there was unanimity, but as to others, there was the greatest possible divergence of opinion, and he thought, in respect of these latter, he might say that the Bill, as framed, really lay in the middle course, between the extreme opinions which had been expressed. To go back to Dr. Siemens's illustration of the previous Thursday, referring to the time when it was determined by Jupiter to give that which persons on the earth unanimously asked for, but Jupiter was never able give to them anything, because they could not agree, it appeared to him that if one were to take the whole discussion, and were to collate the various opinions expressed, it would be found absolutely impossible for the Committee to be guided by those opinions, if they were simply to regard them without having reference to the knowledge of the subject possessed by the different speakers. But as chairman of the Committee, he might undertake to say that every opinion expressed would be thoroughly and duly considered, and the Committee would endeavour to attach such weight to each opinion as, after the best consideration they could give to it, they thought it deserved. No comments had been made on the third and fourth parts of the Bill, as these were purely formal; but one gentleman was good enough to come to him last week, after the meeting had broken up, and suggested that he was not quite clear whether, in Part IV., the transitory provisions, a particular matter had been attended to; he begged leave to express the Committee's thanks for this warning, and to say that the point should be investigated. The discussion had, in fact, turned, as was to be expected, entirely on the first and second parts of the Bill, and he would now deal with those two parts separately; but before doing so, he would just say one word on the Preamble. Admiral Selwyn had complained of the phrase that "new and meritorious inventions should receive all possible assistance and encouragement"—he complained of the use of those words "new and meritorious." Now, it seemed to him those words only implied very necessary conditions. He presumed they did not want inventions that were not new, nor inventions that were not meritorious to receive encouragement, and therefore it seemed to him, as he had said, those words were very properly used. Probably what the Admiral meant was that the introduction of these words into the Preamble might afford excuse for abuse when the Act was put into operation, and that examiners might point to these words as justifying rejection for want of novelty, or of merit, when no such power was given, or intended to be given, by the Act itself. But strictly speaking, this apprehension of an improper use being made of the expression was no reason why the expression, if accurate and proper where used, should be discarded. He was glad to say, however, that they had been advised by the best friends of the Bill to cut out the Preamble altogether, because when the Bill went forward, it might be a matter of contest and of argument whether the Preamble was proved or not; they might not havethe Preamble proved, and therefore, he thought probably, when the Society of Arts' Bill had been finally drafted, all the fine writing in the Preamble would disappear. To come to Part I. The first point that had been objected to was the proposal for defining what should be "subject-matter." As they had been told by Mr. Alfred Carpmael and Mr. Trueman Wood, this point had received a very great deal of attention on the part of the Committee; they were aware of the extreme difficulties of it, and they endeavoured to frame a description which should cover all that "any manner of new manufacture" covered, and to go beyond in those points where it was deficient. Mr. Wood had given instances where the law officer or his clerk refused to grant a patent on account of its not being subject-matter, which patent was granted in America, and America had the profit of the industry, and the patentee had the profit of his invention. On the other hand, he could give an instance which was historically interesting, and showed how under the present "any manner of new manufacture," a patent might be granted for something which certainly a patent ought not to be granted for, according to his judgment. That was the mere mode of ruling an account-book. It was a fact that there was granted, to a patentee of the name of Jones, about the beginning of this century or the end of the last, a patent for a mode of keeping account-books called the British mode of book-keeping. His (the Chairman's) attention was attracted to it in this way; he was reading a bound collection of pamphlets belonging to Telford, the engineer, and in that collection was a pamphlet by Mr. Jones, and appended to it was a receipt for 30s., which was the royalty Telford paid to Mr. Jones, for liberty to rule his books and keep his accounts in the patented manner. He thought they would all agree that a system of ruling a book was not a patentable matter; nevertheless, such a patent passed the examiners of those days. With respect to this question of subject-matter, they had had the valuable assistance of Mr. Trueman Wood, who had had experience in the Patent-office of England, as well as a large experience as Secretary of the Society of Arts; and he had prepared a synopsis of the foreign Patent-laws, every one of which, he believed, gave definitions of what was patentable. England was the only place, as far as he knew—and probably its colonies—where a patent was granted for the indefinite thing, "any manner of new manufacture." As had been properly stated, that meant a patent might be granted for anything which hitherto had been considered to be any new manufacture, or might hereafter be so considered. His own view was that in the Bill, as finally settled, they should retain that phrase, "any manner of new manufacture;" and if, under the advice of the Parliamentary draftsman, they could incorporate with that, their present definition, or an improved one, so as to include those matters which were not now included in "any manner of new manufacture," without losing any which were, it would be wise to incorporate their definition. If they could not do this, he believed the Committee would adhere simply to the old phrase "any manner of new manufacture." They would not forego it, but if they could add to it, well and good. If not, they would retain that in preference to the use alone of their attempted definition. However, as he had said, they were tempted to draw up a definition of what should be patentable by the consideration that nearly every country where there was a Patent-law had such. Now, as to the examination of patents, and the endorsement. One gentleman said he thought a title ought to be examined, and he (the Chairman) thought so too. Some years ago, a patent was granted, the title of which was for "moving heavy bodies," and in the specification there was found described and claimed a beer-engine. Now, he did not think, under the title "moving heavy bodies," a person ought to be allowed to patent a beer-engine, as it would be misleading; no one interested in beer-engines would be likely to be attracted by such a title as "moving heavy bodies," and therefore he would not have his attention called to it. He thought there should be an examination, to see that the title agreed with the invention, and that the invention was covered by the provisional specification; the provisional specification and the title should accord with each other, and the provisional specification should reasonably define the nature of the invention. If it did not, you would get into the difficulty which existed before the year 1851, a date and a difficulty which many of those present might not remember. Before that year the patentee had only to give the title; no provisional specification and no deposit paper were required, and thus the patentee was left at liberty for six months to pick up anything he could which would come within the title, in fraud of anybody he could pillage in that way. That became a very serious evil, and in 1851 there was a regulation of the Commissioners that there should be a deposit paper, which in the Act of 1852 grew into the provisional specification. He thought there was no one who would desire to see that provisional specification abandoned; on the other hand, no one wanted the inventor tied down by it to describe every detail. He ought to give in the provisional specification the fundamental features of the invention, and then, when he came to the complete specification, he ought to be entitled to claim everything which was a fair development of the matters foreshadowed in the provisional specification.

Admiral SELWYN said his observations with regard to that, were in consequence of the present practice, which required the provisional specification and complete specification to be as nearly as possible identical.

The CHAIRMAN said his experience was that that was really not so. There was no examination of the complete or final specification at all, and although in patent actions, it was almost invariably pleaded that the patent was not valid, because the complete specification was in excess of the provisional, he believed he was right in saying that in not one single instance had a patent ever been declared void for that reason. With respect to the examination of the final specification, Mr. Justice Stephen the other night appeared to him to base his objection upon the ground that such an examination would only be of benefit to the plaintiff or defendant in a patent action; and he pointed out there were so few patent actions that it was hardly worth while to institute the examinations for that mere purpose. But it appeared to him (the Chairman) that Mr. Justice Stephen overlooked the real object of having an examination of the complete specification. It was an object in which the public were much interested; it was that the patentee, having a monopoly granted to him, should define thoroughly and clearly to any ordinary reader what he intended to be the limit and scope of the monopoly. It was not sufficient that a man taking up a specification, should say, "I am instructed as a workman how to carry out the invention; I can make this machine." He also ought to be able to say, "Although I make this machine as a whole, and am told how to do it, I distinctly understand that the machine as a whole is not claimed, but that the patent is confined to the claims *A*, *B*, and *C*, or a combination of *A* and *B*, or a combination of *A*, *B*, and *C*, or *A* and *B*, or *B* and *C*, and thus I know that if I do not go within this territory I am outside the patent." He (the Chairman) had heard several times the common phrase used, that a man tried to evade a patent; but he thought this word evasion was not infrequently unfairly used, as applied to persons who desired to keep clear of a patent. As an illustration, suppose a man had a field, could it be said that anybody who skirted the field, and did not go across it, was trying to evade the field. If a man had made an invention, he was entitled to have that as his claim; but he was not entitled to have something he had not made. A patent was not a patent for a principle; it was not a patent for an end; it was a patent for the means of attaining an end. If a man had only invented one means of attaining an end, why was somebody else to be debarred from inventing another means of attaining that end? If there were not this liberty, the grievance would be so intolerable that there would soon be an end of patents altogether. It was on this ground of the need of the clear understanding by the reader of the extent of the patentee's claim, that he thought it was most desirable there should be, as far as possible, a clearly drawn complete specification doing two things—first, the instructing the workman how to make the machine; and, secondly, the informing the reader what was the limit of the patent. Then to guard against the hardship on the patentee, should he, in the first instance, have neglected properly to claim all that, having regard to the provisional specification, he clearly might have claimed if he had been wise enough at the time he filed his final specification, they had provided for the first time, as far as his knowledge of previous Bills went, a good means of amendment of the specification; the present amendment, which was one by way of excision only, was obviously not sufficient; there ought to be the power to amend by way of addition, where something properly claimable had been omitted. An objection had been raised to the provision made, that if any person were manufacturing in accordance with the invention described in the patent, but not claimed, he should be at liberty to continue the manufacture after the supplemental claim was made, and it was said that was a hardship on the inventor. Was it? It must be remembered that they did not propose to restrict this liberty of amendment to two or three years after the granting of the patent; it might be that that would be the most desirable way of doing it, but if some such restriction as to the time within which amendment by way of addition might be made were not provided, such a case as the following might happen. A man who had a patent for 17 years, and had failed to claim *B*, which was described in his specification, and had carefully claimed *A* only, refraining from claiming *B* because, for anything you could tell, he did not believe it to be new or did not think it of importance and another man, seeing *B* was not claimed, manufactured *B*, as he was perfectly entitled to do. He might have put up special machinery, he might have got a trade in it, and at any time in the 17 years it was within the power of the patentee to go to the Commissioners and say I find I was wrong; I might have claimed *B*, and I am now going to claim it. Was the other man's trade to be suddenly stopped? It was agreed that he ought not to be called an infringer for practising the invention before it was claimed, which was obvious, as there was no patent for it; but would t not be hard that his plant was to be laid idle, and his trade stopped, after being allowed for seven or ten years to go on in the belief that *B* did not form part of the patent. It seemed to him there must be one of two things; either there must be this provision, that the person who manufactured that which was not originally claimed, should, after it was claimed, be still allowed to manufacture, or a time must be limited, after a patent was first granted, within which it should be competent to the patentee to extend his claim. One of these two things must be done, or else the public would never know what a patentee could claim or what he could not. Passing to another matter—he was surprised to hear there were still any advocates of an examination into novelty, he had thought that that bugbear was fairly knocked on the head. Seven years ago, when the matter was discussed, there was an apparent unanimity of opinion that an examination into novelty should not be made. He did not generally like to quote himself, but he would refer anybody who had a copy of his paper on the "Expediency of Protection for Inventions" to page 102, where a suggestion was made as to what would happen if James Watt had gone before an examiner into novelty with the patent for the improvements in the steam-engine. Any examiner knowing all about the steam-engine as made by Smeaton, and existing at that time, examining into novelty or utility, would never have granted Watt his patent. He believed the examination into novelty was a most mischievous one, A man came and said he wanted a patent for a new machine. He was asked what were its component parts, and then he said, "There is a wheel, a crank, a connecting rod," and so on. The examiner would immediately say, "The wheel is old, the crank is old, and the connecting rod is old." "Well, but they are combined in a new way for the first time." The examiner says, "Anybody can do that; you cannot have a patent; there is want of novelty." But let that thing be made, and go to work, and become a really useful machine, and be brought into general use, so that it was worth somebody's while to infringe it, and then when the defendant went into Court and said "this is not new," it would be found that an invention which has got the prestige which attaches to large and successful working would be looked upon in a very different way by the Court, who came to consider whether it was new or not, from the way in which it would be treated by an examiner, who looked at a mere crude idea upon a piece of paper, and, having found out that the elements were old, said there was nothing new in the combination, and therefore there was nothing new in the invention. He was certain that there would be infinite mischief in such an examination.

Mr. ALEXANDER said he wished it to be clearly understood that the examination he recommended was only advisory, and that the examiner would have no power to refuse a patent, but only to give an opinion which would be helpful to the applicant.

The CHAIRMAN said that was a sort of paternal government, which appeared to him to give an applicant for a patent something like a privilege which might be given to a person thinking of beginning a law suit, to go to an officer of the Court and say, "Do you think I am likely to succeed if I bring this action?" He could not see why any patentee should have that sort of fatherly advice given to him whether he should have his invention or not; let him search out novelty or non-novelty for himself, or by means of his agent. If the examination were to be of any good it ought to be final, and there ought to be power of rejection. Such a course was consistent with the argument he had often heard used used in days gone by, when an examination into novelty was recommended, and this was, that those patents which passed were all the more valuable, as they went forth with a sort of Government stamp attached to them: "We declare this to be new as far as we know." But if it were nothing more than friendly advice that was proposed, it appeared to him that it was giving that kind of paternal assistance to a class of her Majesty's subjects, on a particular matter, which was not given to the general public in other matters of equal importance to them. Then it was also said, there ought to be no endorsed patents, and some speakers said there should be no appeal, let the decision of the examiner be final. They had thought that very hard, and proposed there should be an appeal; and if even on appeal you could not satisfy an applicant that he was wrong, they would let him have his patent, but they at all events let the public know what was thought of it. Then, again, an objection had been made to the compulsory license, for inventions used by the Government for military purposes. Up to the present time, the Government could use, and did use, an invention without paying anything at all, and, therefore, the suggestion that they should pay like any subject was very much in favour of the patentee, and also in favour of the Government, as he believed, because it would get for the Government the patentee's help in carrying out the invention. This proposition was an improvement on anything which existed now, but it was no more than was proposed in the Bill of 1879; for that Bill did give to the patentees the same as was now proposed; but then it provided that, for the purposes of war, the Government, or any person manufacturing for the Government should be allowed to take an invention, and to settle the terms with the patentees afterwards. What would be thought of a man who had a water bucket standing outside his house, and his neighbour's house being on fire, the neighbour comes to take the bucket of water, but the owner says, "No; you have not settled with me what you are to give me for it; you have not my consent; it is my bucket, and you must settle the price with me before you have it." Would it not be reasonable to let the neighbour have the power of taking the bucket to extinguish the fire, leaving the price or the hire to be settled afterwards. This illustration covered all that was proposed here—that for warlike purposes the Government, instead of waiting until they could come to an agreement with the inventor, should be at liberty to take the invention, as they were now; but having taken it, they should be compelled to pay some sum to be agreed upon, or to be settled by the Commissioners if agreement could not be arrived at. It appeared to him that no one would approve of a Bill which prevented the Government of the country availing itself of all the knowledge in the country for its defence. With regard to the question of fees, the Committee had adopted the fees proposed by the last Bill, modified simply to suit the term of 17 years instead of the 21 years; but the matter of fees was one which they were quite willing to reconsider, leaving it to those who had to look after the revenue to say whether the proposition they might make would be acquiesced in or not. But what were the payments to be? One gentleman said, "Whatever you do, do not have periodical payments, it is all wrong; pay a lump sum down, and have done with it." Immediately afterwards, another gentleman got up and said, "The true remedy for the whole thing is not to have periodical payments at three or four intervals, but to pay a little every year." Those were two instances of absolutely opposite suggestions which the Committee had for their guidance, and he thought that, as regards the mode and times of payment, they had steered midway between them. It seemed to him the best plan, and between the two, was to pay at different periods, as was done now; and he could not help saying, with all deference to the speaker who proposed the lump sum, that, in his (the Chairman's) opinion, it was desirable patents which the owner did not care to keep up should lapse at the end of three or four years, rather than that they should remain for the full term, without anybody knowing whether they were or were not to be regarded as patents at all. Under such a state of things, they would not be patents for any practical purpose; the public would derive no benefit from them; but they would turn out to be patents, if somebody wanted to use any part of them in another invention. It seemed to him, therefore, extremely desirable that there should be liberty for persons, without further loss, to retire at stated periods by refraining from paying the fees. The first speaker that evening alluded, as an objection, to the fees being paid by stamps, but there they had simply followed the provisions of the 1879 Bill and the present practice. He did not quite understand Admiral Selwyn when he said that patents should not be granted which infringed others. Many patents ought to be granted which did infringe others. A man might have had a patent for a steam-engine, and someone took out a patent for a compound cylinder engine. A compound cylinder engine could not be worked without infringing a steam-engine, but would anybody say he should not have a patent for it? An infringing patent often contained a valuable improvement.

Admiral SELWYN said the Chairman did not appear to have understood him. He was speaking of what was called an infringement of a patent by the examiner in the United States; that was, copying the words used in a previous patent.

The CHAIRMAN said that was not what he meant by it. Many valid and useful patents could not be exercised without infringing a previous patent, and, therefore, when he heard the suggestion that any patent which could not be put to work without infringing another should not be granted, he was very much surprised.

Admiral SELWYN said he had no such meaning.

The CHAIRMAN said a suggestion had also been made, that a foreign patentee ought to be allowed to take out a patent at any time after the date of his foreign patent, but that seemed to him very undesirable. Supposing an invention had been patented in America, and the goods had been manufactured there; everybody knew all about it in England, but nobody could set up the manufacture in England for 17 years, because he never could tell whether the American patentee was coming over to patent it or not. He did not think it was desirable. It appeared to him it would be a very great bar to manufacture in this country, and that there should be some reasonably restricted period within which the patentee should have the option to take out his patent here; it would be seen that the words, "twelve months" were in italics, and that the Committee left the exact period for future determination. Admiral Selwyn suggested that the term should be coincident with the eighteen months allowed for the protection of inventions shown at an international exhibition, and that was a question of degree, to which there could be no objection; but, as he had said, it appeared to him (the Chairman) that there should be some limit within which a foreign inventor might exercise his option of taking out a patent, or else it left English manufacturers in the condition that it was impossible to tell whether they were or were not at liberty to make the foreign patented article. He would not occupy time any longer in discussing the first part of the Bill, so far as the objections to it were concerned, but he thought, as it had had so few friends, he must befriend it, and point to one or two matters which had not been condemned. The first was the spirit in which the Bill had been drawn—that of the identity of interest between the patentee and the public, on the ground that an unowned invention was one that it was no one's interest to develop; next, there had been an unanimous approval of the suggestion, now made for the first time, that it should be no defence to a patent action where a man infringed *A*, that *B*, which he had not infringed, was invalid. They proposed that the plea should be at an end for ever, and he thought every one who had spoken on the Bill, or studied the matter, agreed that, at all events, in that respect they were right. They also proposed this power of amendment by way of extension of the claim, and every one seemed to be pretty well agreed that that was right. They further proposed that the patent should not be revocable for non-user, coupled with the condition that the patentee should be compelled to grant licenses. The Government Bill of 1879 contained, adversely to the patentee, the following clause, viz., that if a patent were not put into use for a certain time, it should be revocable, and also a clause for obligatory licenses. The framers of this Bill said, "No; if there were stringent conditions in it to compel a patentee to license others because he was not satisfying the demand of the public, they ought not at the same time to threaten him with revocation if he could not get his patent introduced." That was a very great improvement as compared with the 1879 Bill. In his judgment, the examination, including the examination of the complete specification, so as to enable the readers to ascertain what was the scope of the patent, was a great improvement, though he knew that proposition was by no means unanimously concurred in. Then there was another point about which he was very much astonished—that which had been called, for conciseness sake, the "dormant publication." When they framed this Bill, and suggested that if a matter had been dormant for 30 years it should not be held to anticipate an invention, and to render a patent invalid, they expected an outcry against such a proposition, but not only in that room, but in another place, they were surprised to find that, so far from this proposition being rejected as going too far, it was commented upon as not going far enough. They were met with this observation: "Why destroy the provisional specification; why deprive industry of so much invention?" He must say this suggestion fairly took away his breath. If the idea were adopted, they would have to alter the meaning of invention, so that a person applying for a patent might declare somewhat as follows:—"Whereas I have read in the Patent-office a provisional specification lodged there by somebody else, and he did not perfect his patent, now I, *A B*, claim to be its inventor, and to have a patent for it." Think of the search which would occur each month, as the provisional specifications which had not proceeded to the seal, became known, what a rush of so-called inventors there would be to see what they could pick up out of them. It seemed to the Committee such an extraordinary proposition that they would never have dared to put it forward; nevertheless, they had heard the suggestion made by so astute a man as Mr. Webster, "Why give up so much invention?" The Committee thought they had done enough when they said that publications of more than 30 years old should not invalidate a patent, and he thought, on reflection, the public would come to the same opinion. But what a step that was in advance. At the present time, no matter how good an invention was, if you could find some book in the British Museum, not read by one reader in ten years, you could rake it up and produce it in Court, and it was a publication within the meaning of the Act; and the most valuable invention might be made invalid on account of it. For the first time they grappled with that evil, and made a proposition that they all thought would be objected to as being too startling, whereas they found that not only was their principle accepted, but they were blamed for not having extended their limits of its practical application wider than they had. Those were the principal matters in the 1st part of the Bill, and he now came to the 2nd, that which related to the trial of patent actions. He had an opportunity of talking on this matter with Mr. Justice Stephen before the first meeting, when that gentleman expressed to him his strong disapprobation of the 2nd part of the Bill. He (the Chairman) then invited him, as he presided at a meeting seven years ago, when the patent question as a whole was discussed, to come and preside at their first meeting, and give them the benefit of his criticisms, because the Bill was not put forward by the Committee as something which they believed could not be improved, but as a draft of a comprehensive Bill dealing with the subject as a whole, and needing therefore all the aid to its preparation which could be given by criticism of the draft, whether that criticism were favourable or not. There had been various little attempts from time to time to improve one section or another of the existing Act, but they were now endeavouring to frame a Bill as a whole, they desired to make it the best they could, and, therefore, they wanted to hear all that could be said against it as well as for it, so that they might go again to the Council of the Society of Arts, who had only provisionally adopted the Bill, and say this is the result of the information we have derived from various discussions, this is our present view of what is best to be done, and then, when the Council approved the final Bill, they would take the ordinary means to bring it to the notice of the Government, in order that, if they did not adopt it in its entirety, they might, at all events, adopt such parts as should be judged expedient in the interests of the public. It was with the sincere desire to profit by the adverse criticism which Mr. Justice Stephen warned him he should make, that they begged that learned Judge to preside. He was sorry, indeed, to hear Mr. Justice Stephen say that he could not help regarding part 2 of the Bill as a snub on the English Judges, because he said it only referred to England, and he mentioned Scotland, the Isle of Man, and several other places where the Bill left things as they were now, and therefore Mr. Justice Stephen suggested that the framers of the Bill must mean that the persons whose ability to try patent cases was attacked, were simply the English Judges. Now, he felt quite sure that this was a jest on the part of Mr. Justice Stephen, but he must ask, was Mr. Justice Stephen warranted in this inference, even in jest? If so, what must be thought of the Judicature Act itself, passed in 1873? That said: "Whereas it is expedient to constitute a Supreme Court, and to make provision for the better administration of justice in England," not in Scotland, not in Ireland. Was justice in England so very bad, and did that Act point particularly to English Judges? Had they never heard of separate legislation for England, more especially when the measure was a tentative one? It was not infrequent to have measures, as in the instance of the Judicature Act, simply applying to England, at all events in the first instance. But he believed after all that the observation was intended to be jocular. He was sure that no one could really regard the Bill as being intended to snub the English judges. It was almost unnecessary to say that, if you were to canvass every intelligent man and woman as to what it was in England, of all others, they would point to as being that which they would hold up to the admiration of other countries, they would say "their Judges." He did not believe there was a body of men in England so thoroughly reverenced as the Judges, for their position, their ability, their earnest attention to their duties—bringing their whole mind and thought to bear,—and their absolute, unswerving desire to do right between man and man. It would be affectation not to allude to the relationship which existed between himself and one of her Majesty's late Judges; and, that being so, he, at all events, should be the last man to be less fervent in his admiration of the Bench than were the general public; and he desired to say in the most earnest manner for himself, that he knew no body of men whom he reverenced as he reverenced her Majesty's Judges. But although one reverenced the Judges when engaged in work to which they were permitted to give their attention and devote themselves, it did not follow that one should not endeavour to obtain a new tribunal for patent actions, when it was found that the Judges were controlled in their functions by an Act of Parliament, which pointed out, as he read it, that they should not try patent actions when they were at all complex; and when it was the fact, that the Judges, under this Act, felt themselves bound to drive patent litigants from the judgment seat—when that was the state of the case, was not one justified in endeavouring to find some other tribunal? Mr. Justice Stephen in effect said that if, Gallio-like, the Judges drove patent litigants from the ordinary tribunals, a remedy must be found for such a state of things. The question, therefore, arose, were patentees driven from the judgment seat? He said yes; not very frequently it was true, but the practice had commenced, and now a litigant could never tell whether he would be allowed to remain before the judgment seat or not. He would just read sections 56 and 57 of the Judicature Act, to show what was the present state of the law. The 56th section ran thus:—"Subject to any rules of Court and to such right as may now exist to have particular cases submitted to the verdict of a jury, any question arising in any cause or matter (other than a criminal proceeding by the Crown) before the High Court of Justice, or before the Court of Appeal, may be referred by the Court, or by any Divisional Court or Judge, before whom such cause or matter may be pending, for inquiry and report to any official or special referee." Then omitting some words, it went on, "The High Court, or the Court of Appeal, may also, in any such cause or matter as aforesaid, in which it may think it expedient so to do, call in the aid of one or more assessors specially qualified, and try, and hear such cause or matter, wholly or partially, with the assistance of such assessors." Then, section 57 says, "In any cause or matter (other than a criminal proceeding by the Crown) before the said High Court, in which all parties interested, who are under no disability, consent thereto, and also without such consent in any such cause or matter requiring any prolonged examination of documents or accounts, or any scientific or local investigation which cannot, in the opinion of the Court or a Judge, conveniently be made before a jury, or conducted by the Court, through its other ordinary officers, the Court, or a Judge may, at any time, on such terms as may be thought proper, order any question or issue of fact, or any question of account arising therein, to be tried either before an official referee, to be appointed as hereinafter provided, or by a special referee to be agreed upon between the parties." To revert to Mr. Justice Stephen's joke about snubbing the English Bench, again he would point out that it was the Judicature Act which in effect told the English Judges, and the English Judges only, that when a patent action was a complex one, these Judges could no longer be considered as forming a fit tribunal. The Judicature Act being that which it was, what did it point to? In his judgment it pointed to this, that the Legislature thought the ordinary Courts very likely were not, in many cases, desirable Courts for trying such cases, and they gave the Judge power to send litigants from the Court to an official referee. That power was exercised. He had before him the shorthand notes of a trial where the Judge did, in spite of the insistance of the parties to the contrary send a patent action to be tried before an official referee. It was in the discretion of the Judge, but who could tell how the Judge would view the case? According to the habit of mind of the Judge, and exercising his discretion (not in the least capriciously), Judge *A* would say, "This case I can try, I have not the least trouble with it;" but Judge *X* might say of the very same case, "I feel that this case cannot be conveniently tried, I will send it before an official referee;" and the litigants could not tell whether they were going before Judge *A* or Judge *X*, and even if they could, they did not know the tenor of mind of Judge *A* or Judge *X*. Moreover, neither of those Judges could say, without having heard the case opened, whether it was one which, in his judgment, ought to be sent to an official referee. What happened, therefore? The litigants in patent actions went to one of the ordinary Courts of law, for the purpose of having the case tried. They had to go to the expense of counsel, solicitors, witnesses, models, every preparation for the trial, and when they got into Court, and the case had been opened, the Judge might say, "I find this is a case I cannot hear; you must go to an official referee." And there was this anomaly; the more complicated and intricate the case, the more certainly would it be sent to an official referee. The Committee were twitted a good deal about the omniscience of their suggested tribunal, and curiously enough, invariably when so twitted, the legal member of that tribunal had been dropped out of the speaker's observations. It was always the omniscience of the engineer and the chemist; not a word had been said, except in the most incidental manner, about the benefit of having the legal man there, though he was one of the three. But what was an official referee? He was a barrister; a gentleman of position and good standing, and nothing more. He was of no higher position or standing than they might fairly expect to find in the legal member of the Commission. Yet this was the person who, unassisted by assessors, was to try, not easy patent cases, because they would be tried by the Court; but he was the man to try the difficult patent cases. Therefore, the law now said this, you are to go to the Court to find whether the case shall be tried or not. If it be a simple one that anybody can try, it will be tried by the Court. If it be a difficult one, and you are before a Judge who does not like difficult patent cases, then he would exercise his discretion and say: "You shall go to the official referee," who is simply a barrister of no quality higher than that which might be reasonably expected in the legal member of the tribunal the Committee suggested, and, moreover, was unassisted by a chemist or by an engineer. Was it suggested that the addition of a chemist and an engineer to the barrister would do him any harm. That seemed very unlikely. Further, after having been accused, first of all, of claiming for these gentlemen omniscience, in the next moment they were accused because, not crediting them with omniscience, they gave them the power of calling in special assessors for cases to which they felt their knowledge did not extend, and they were told they were putting assessors on assessors. It really appeared absolutely impossible to satisfy anybody when they proposed a tribunal which was better, he would untertake to say, than the tribunal to which the Judicature Act pointed, as being the one to try all the difficult patent cases. As long as they were simple they were to be tried by the Court, but when not simple, they were to go to an official referee, who was a barrister, unassisted by any person of any kind or description. It was obvious their tribunal must be a better one than that of the barrister sitting alone, and he thought when some of the speakers inveighed against these propositions, they had not present to their minds the real facts of the case as regards the condition of the law as it now stands. He must claim Mr. Justice Stephen himself as a witness in favour of that which, in patent actions, was proposed. He agreed that if litigants were driven away from the Courts they had cause to complain. Now it was established that they were driven away. The Judicature Act ordered the Judge to drive them away in complicated cases. Mr. Justice Stephen said he would remedy this by having a Judge with assessors. That provision was already in the Judicature Act, but so far as he (the Chairman) knew, from 1873 to the present time, it had only been acted in two instances, neither one being one of a patent action. Then it was said there were only nine patent cases proper per annum, and that even if these were taken to the new tribunal, it would leave to the Courts all such cases as those relating to licenses, to the discharge of servants, and to other matters which frequently involved questions of patents. This was all very true; but because you could not remove every case from the Court, was it any reason you should not remove those that could be removed? It appeared to him such a suggestion amounted to this—if you cannot have perfection, do not endeavour to have improvement; this they did not think was reasonable; therefore, they said, at all events, take away these patent cases from the Courts. As regards Mr. Justice Stephen's remarks, that you could not try a counter-claim, that was true, but he should like to know how many counter-claims had been set up in patent actions; he did not remember one, and he thought they had better forego that minute advantage, rather than not have a more satisfactory tribunal to try the patent action proper, than the one to which the Judges sent them, namely, an official referee. They had heard from Admiral Selwyn the answers of the ex-Commissioner of Patents in America, from which he gathered that the tribunal of first instance there was the Commissioner, with assessors if need be. That appeared to be a tribunal of the same character as they proposed, excepting that in America there was an appeal to the Court. What was the other suggestion of Mr. Justice Stephen? They had heard a great deal about the palladium of British liberty, the British jury, and yet the suggestion was that in all patent actions the litigants should not be allowed to have a jury at all, in order that these actions might be tried by a Judge with assessors. That was the suggested improvement, and he believed it was a good one, but there were a great many who thought juries should not be done away with. Mr. Justice Stephen had certainly hit one technical blot in the Bill, and that was with regard to the pleas. Instead of saying that for the future such and such pleas should not be pleaded, which would have been the safe way of doing it, they had been unwise enough to say that such and such pleas only should be allowed. The error had already been discovered in respect to two, and the other errors should also be remedied; but it must be remembered that, while pointing out the technical error, Mr. Justice Stephen agreed that the object the framers of the Bill had in view, the getting rid of pleading the invalidity of *B* as a justification for infringing valid *A*, was an excellent one. He feared they would think he had detained them unnecessarily long on this 2nd part of the Bill, when he told them the Committee proposed to abandon it; but he had done so because he thought it was only right that the Committee should justify themselves, and should state their reasons for having drawn this part of the Bill. Mr. Justice Stephen agreed that they had a right to complain if patentees were driven from the judgment seat, and there was no doubt they were so driven away. He also agreed that the present tribunal was not all that could be desired, and therefore he himself suggested that there should be an alteration. He (the Chairman) thought these were grounds why an attempt should be made at improvement, and therefore it was they drafted Part 2 of the Bill. As he had said, the Committee proposed to withdraw this Part 2, but in considering the propriety of doing this, it had occurred to them that there was yet a mode by which they could obtain very much of what they desired, while leaving the present tribunal all their powers and privileges. There were three suggestions upon which he had consulted Mr. Justice Stephen, and he had his authority for saying that as regard one of the three, he entirely concurred in it; as regarded the other two, he had not had time to examine them thoroughly, but so far as his first impression went, he did not see any objection to them. These three suggestions were as follows. At the present time it obviously was the right of any brace of litigants to say we will refer our quarrel to arbitration, and they were conferring no new right on litigants by saying that might still be done; but they proposed that it should be part of the duty of the three Commissioners to act as arbitrators, when the parties agreed to come to them. The object of inserting such a provision in the Bill, was to prevent the Commissioners from refusing to become arbitrators on the ground that it was no part of their duty. The second proposal was that, wherever under the Judicature Act the Court or a Judge would otherwise have remitted a patent action to an official referee, they should have power to remit it to these three Commissioners, who again, as part of their duty, should be compelled to entertain it, when sent to them. Those were two matters on which Mr. Justice Stephen said he could not give a definite opinion, though so far, he saw no objection to them. The third was, that wherever, under the Judicature Act, the Court, or a Judge, availed itself of the power of having assessors to try a case of this kind, it should be enabled to call upon these Commissioners, or upon such of them as it might think fit, to act as assessors, and again it should be the duty of the Commissioners to sit with the Judge. This last proposition had Mr. Justice Stephen's hearty concurrence. In this way, it was believed many of the benefits which it was thought would have attended the establishing of the new tribunal would be obtained, while they would get rid of that part of the Bill which had given offence to so many. Although this Part 2 was to be abandoned, he by no means regretted that it had been brought forward. It had given rise to a very lively discussion, and had brought to the notice of many who did not know the facts, the extremely unsatisfactory condition of things at present; and thus he hoped a speedy remedy would be devised, a remedy which, otherwise, might have been delayed for a long time. He would repeat that they did not feel there was any need to apologise for having brought Part 2 forward, and for offering it for discussion, although they saw their way now to do without it, as if these three propositions were put into the Bill such a course would, in all probability, meet the case. He believed many litigants in patent actions would elect to go to arbitration before the Commissioners, and also that the Court would see the reasonableness of sending cases if they were empowered to do so, to the Commissioners, rather than to the official referee, who sat without any scientific assistance whatever. He believed, further, the advisability of frequently summoning those gentlemen to sit with the judge as assessors in those actions they determined to try in Court, would likewise be seen With these observations he would bring the discussion to a close, fully conscious that he had not answered anything like all the points that had been touched upon, which, indeed, it would have been impossible to do in the time, but he trusted he had answered the most important objections.

Admiral Selwyn asked what it was proposed to do with regard to trade marks.

The Chairman said it was proposed to bring them under the Commissioners. In conclusion, he desired to repeat in the most emphatic manner that so far from having intended any disrespect whatever to the existing tribunals by the provisions of part 2 of the Bill, his feelings, and those of the Committee, were feelings of unmixed admiration and reverence for her Majesty's Judges, individually and collectively.

Mr. Scott proposed a vote of thanks to the Chairman, which was carried unanimously, and the proceedings terminated.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

January 11.—A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. Barff, M.A.

January 18.—"The Relation of Botanical Science to Ornamental Art." By F. Edward Hulme, F.L.S., F.S.A.

January 25.—"The Causes and Remedies of Bad Trade." By Walter R. Browne, M.A.

February 1.—"The Manufacture of Ordnance." By Colonel Maitland. Sir Frederick Bramwell, F.R.S., Chairman of Council, will preside.

February 8.—"Stained Glass Windows." By Lewis Foreman Day.

February 15.—"The Teaching of Forestry." By Colonel G. F. Pearson. Sir John Lubbock, Bart., M.P., F.R.S., will preside.

FEBRUARY 22.—"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON.

MARCH 1.—"Secondary Batteries." By A. DE MERITENS.

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

JANUARY 31.—"The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By WILLIAM COCHRAN.

FEBRUARY 10.—"Notes on the Trade Capacities of Newfoundland." By E. HEPPLE HALL.

FEBRUARY 28.—"The Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. NOEL SHORE, author of "The Flight of the Lapwing."

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APRIL 25.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Moscow.

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

JANUARY 26.—"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By Dr. THUDICHUM.

FEBRUARY 23.—"Photometric Standards." By HAROLD DIXON.

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON.

APRIL 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS and PERCY C. GILCHRIST.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

JANUARY 13.—"The Opium Trade." By Sir RUTHERFORD ALCOCK, K.C.B. Lord ABERDARE, P.R.G.S., will preside.

FEBRUARY 17.—"Private Enterprises in India." By J. M. MACLEAN.

MARCH 17.—"Village Life, and the Village System in the Bombay Presidency." By W. G. PEDDER.

MARCH 31.—"The Mineral Resources of India, and their Development." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

APRIL 21.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 12.—

MAY 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks in India." By J. R. ROYLE.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Second Course will be on "Recent Advances in Photography." By Captain ABNEY, R.E., F.R.S.

January 30; February 6, 13, 20.

The Third Course will be on "Hydraulic Machinery." By Prof. JOHN PERRY.

March 6, 13, 20, 27.

The Fourth Course will be on "Book Illustration, Old and New." By J. COMYNS CARR.

April 20; May 1, 8, 15.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 2...Institution of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. W. J. H. Whittall, "The Rates of Fatal Accidents."

Victoria Institute, 7, Adelphi-terrace, W.C. 8 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. R. S. Ball, "Comets."

TUESDAY, JAN. 3...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. R. S. Ball, "The Sun, Moon, and Planets." (Lecture IV.)

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m. Annual Meeting.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Frof. Owen, C.B., "*Dinornis* (Part xxiii.): containing a Description of the Skeleton of *Dinornis parvus*, Ow." 2. M. L. Taczanowski, "List of the Birds collected by Mr. Stolzmann in North-eastern Peru." 3. Mr. Martin Jacoby, "Descriptions of new Genera and Species of Phytophagous Coleoptera." 4. Mr. Oldfield Themas, "The African Mungooses."

WEDNESDAY, JAN. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Juvenile Lectures.) Mr. W. H. Preece, "The Wonders of Electricity." (Lecture II.)

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. H. Syer Cuming, "St. Milburga, Abbess of Wenlock." 2. The Rev. C. Collier, "Discoveries in Redenham-park, Andover."

THURSDAY, JAN. 5...London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Henry Morley, "The Essay in the 19th Century."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Popular Lantern Display.

Royal Institution, Albemarle-stneet, W., 3 p.m. Prof. R. S. Ball, "The Solar System further considered." (Juvenile Lecture V.)

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. General Meeting.

FRIDAY, JAN. 6... Geologists' Association, University College, W.C., 8 p.m.

SATURDAY, JAN 7...Royal Institution, Albemarle-street, W. 3 p.m. Prof. A. S. Ball, "How we Learn Facts in Astronomy." (Juvenile Lecture VI.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The second of these lectures on the "Recent Wonders of Electricity" was delivered by Mr. W. H. PREECE, F.R.S., on Wednesday, 4th inst., when numerous illustrative experiments were performed. The principle of electric fuses for blasting purposes in mines, discharging torpedoes at a distance, firing broadsides, &c., was shown by experiments arranged by Prof. Abel, C.B., F.R.S. A fine series of vacuum tubes was shown by Mr. Apps. Mr. Becker lent for exhibition a model incandescent lamp worked by a bichromate battery. The process of electrotyping was shown by Mr. Bolas, F.C.S., and two handsome shields were exhibited by Messrs. Elkington. The meeting-room was lighted, as on the previous occasion, by the Edison Company, and the various appliances for lowering the light and breaking the circuit were exhibited, as well as the "safety catches" used to prevent accident, in case of the interruptions of the circuit. Messrs. Robey again lent the engines by which the Edison dynamo was driven. The meeting was concluded by a cordial vote of thanks to Mr. Preece.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

In connexion with the course of Cantor Lectures, which will be delivered by Captain Abney, F.R.S., on "Recent Advances in Photography," in January and February next, it is proposed to hold, in the House of the Society of Arts, an Exhibition of Photographic Appliances.

The dates of Captain Abney's Lectures are January 30th, February 6th, 13th, and 20th. The Exhibition will be kept open from January 30th till about the end of February.

The Exhibition will be of a technical character, and it is not, therefore, desired to collect photographs of artistic merit only.

The following are among the principal classes of objects sought for exhibition :—

Apparatus ; cameras, lenses, tents, instantaneous shutters, slides, sensitometers, lamps (intended specially for photographic purposes), enlarging apparatus, printing and mounting apparatus, &c.

Photographic materials.

Illustrations of new processes ; negatives and prints produced by new or special processes.

Appliances used in reproductive processes ; specimens of illustrations produced by such processes ; specimens of historical interest, as illustrations of old processes.

Lighting ; models illustrative of characteristic features in the construction of glass houses ; methods of fixing glass without putty or similar material ; arrangements for the production of artificial light for photographic purposes ; apparatus illustrating applications of photography to scientific purposes.

Any person wishing to exhibit any of the above is requested to communicate with the Secretary of the Society, who will supply printed forms of application for space, and will be glad to give any further information required.

Arrangements are being made for showing the actual working of some of the more recent processes.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon ; the label must be suitable for plants in open border. These considerations will principally govern the award.

The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

CANTOR LECTURES.

SOME OF THE INDUSTRIAL USES OF THE CALCIUM COMPOUNDS.

By Thomas Bolas, F.C.S.

Lecture I.—Delivered November 21st, 1881.

Distribution and occurrence of calcium in Nature. Carbonate of lime as limestone, chalk, marble, calcspar, shells, &c. Notes on some of the calcium minerals. Short survey of the chemistry of calcium and of its derivatives.

Jules Verne characterises the pick as the prince of tools; the breaking of the surface of the ground, with the view of utilising the underlying treasure, or of employing the hard materials of the earth for constructive purposes, indicating a progressive civilisation far ahead of that of the more primitive or pastoral era in the history of a race.

Millenium after millenium passed over advancing civilisation before mankind received a second instrument comparable to the pick. This came, however, in the form of the slide-rest, invented, as it were yesterday, by Maudslay. The pick may be regarded as the key which serves to unlock Nature's stores of calcium and other mineral wealth, just as the slide-rest forms the essential of almost every modern machine-tool, and indirectly underlies the abundance and cheapness of the numerous conveniences, luxuries, and easy means of culture which characterise the time we live in.

Calcium, however, precedes iron, at any rate in our own country, as regards industrial importance, because were it not for lime, the manufacture of iron from the abundant clay ironstone would not be practicable. In smelting this ore of iron, limestone is added, and the lime, in uniting with the clay, forms a fusible glass or slag, which runs down, and renders it possible for the particles of iron to agglomerate. Were it not for the lime, all the particles of iron would be so separated from each other by the comparatively infusible clay, that isolation or utilisation of the metal would be impracticable. The service of calcium in this regard does not stop here, as the slag itself has recently been applied to many important industrial uses; some of which will be illustrated to you during the course of these lectures.

Although we might not be quite justified in removing iron from its throne and hailing calcium as the principal offspring of the pick and the king of metals, we should not forget that calcium plays a much more various part in the economy of civilisation than iron. Iron is principally of use as an isolated metal, calcium is only important when combined with other elements.

The metal calcium forms about one fourteenth part, by weight, of the known materials of the explored parts of the earth; an enormous proportion, considering that nearly 70 elementary bodies are at present known to chemists, and that carbonate of lime, the most abundant calcium mineral, contains only 40 per cent. of the metal, the remaining 60 per cent. consisting of carbon and oxygen.

Calcium carbonate, or carbonate of lime, forms whole mountain ranges: fertile and inhabited islands, standing up in the midst of the ocean, consist also of this mineral; and the sight of England's chalk cliffs has cheered and gladdened the heart of many a poor Channel-sick traveller returning to his native land. Calcium, often in the form of carbonate, penetrates into almost any bye-path of existence, whether animal, vegetable, or mineral; and it would indeed be difficult to find any great work of civilisation not essentially dependent on calcium; much more difficult it is to tell you where calcium is not than where it is.

Yet, in the face of all this, the isolated metal calcium is a dwarf, a pigmy; although in combination calcium is as a giant, isolated it is as nothing. Probably, at the present moment, there is not half-a-pound of isolated calcium metal in the whole of the world. Calcium, as an isolated metal, is an outcome of the new metallurgy of Sir Humphry Davy; and, although the time for the industrial application of Davy's metals has not yet arrived, there can be but little doubt that it will come.

Davy, who may be regarded as the Tubal Cain of modern times, obtained many strange metals from bodies which were not supposed to contain anything metallic. Seventy-four years ago, this white substance, the alkali potash, was an enigma; but Davy subjected it to the decomposing influence of electricity, and it yielded a remarkable metal, bright and lustrous, but having a most remarkable affinity for oxygen. Note the result, when a small piece of this metal is thrown on the surface of water. It decomposes the water, and liberates hydrogen; the heat evolved by the reaction being so intense, that the hydrogen inflames, and it appears as if the potassium were burning. Soda yields the metal sodium, an elementary body closely resembling potassium, while magnesia yields a more permanent metal, one which may be freely handled, and even dipped in water, without any violent disturbance of the elements; and when this is burned, it emits the well-known white, and highly actinic "magnesinm light."

Before illustrating to you the isolation of calcium by the decomposing action of the form of strength known as electricity, it may be well to show you an example illustrating the extreme ease with which several metals can be isolated by this agency.

Before you is a small gas-motor, or a machine by which a portion of the force which results when coal-gas is burned, is converted into motive-power. This motive-power turns the armature of an apparatus, which can transmute the motion into electricity; the machine used in this case being the beautiful apparatus invented by Professor Pacinotti, of Pisa, about twenty-one years ago, and often called a "Gramme" machine now-a-days. The electric current from the Pacinotti machine is led by these wires to a glass trough, containing a solution of cyanide of silver, in cyanide of potasium, and through which solution it passes. The copper plate connected with the negative wire becomes, as you see, immediately coated with a uniform or compact film of reduced silver. This is, in fact, the ordinary process of electro-plating.

Now, for the isolation of calcium by the agency of electricity. Lime, as you know, is a compound of calcium and oxygen; but it is more convenient to decompose the chloride than the oxide. In this small iron crucible there is some calcium chloride, the compound being kept in a state of fusion by means of a small gas furnace. The positive wire of the Pacinotti machine being now connected with the crucible, the negative wire is joined to a piece of iron-wire, which just peeps out at the end of a clay pipe-stem. The end of the pipe-stem, through which the iron negative terminal passes, is now placed just under the surface of the fused calcium chloride, and Mr. Barker will again set the gas-motor in action. Every now and then, those of you who are well placed, may notice a slight flash as a bead of calcium becomes detached, rises to the surface, and burns; but in order to catch a bead, it is necessary to lower the heat till the calcium chloride near the surface is on the point of solidifying. Now, the wire on being lifted out, bears with it a minute bead of calcium, but it is far too small for you to see. Still, never mind, it can be made manifest by its works; it will decompose water, and the reaction may be made obvious to you all. On the stage of the lantern is a small trough of water, and now that the minute bead of calcium has been freed from its incrustation of the fused chloride, it will be dropped into the water; you see the magnified image of the bead of metal projected on the screen; and you see that bubbles of hydrogen are liberated.

Here, then, is isolated calcium, the merest pigmy, a nothing as regards industry and the operations of the world in general; the isolation of the minute bead which was produced a few minutes ago has involved no small amount of work, although the bead did not, in all probability, weigh as much as a quarter of a grain.

Turn now to the abundant, various, and often exquisitely beautiful carbonate of lime, some fragments of which are before you. Here it is in the amorphous state, as limestone, yonder as coral, and here in clear and colourless rhombohedral crystals of calcite, or Iceland spar.

A rhomb of Iceland spar is now placed on the stage of the lantern, and behind it a black shade, in which is a small round hole. This hole being focussed, two images are projected on the screen; the crystal of spar having the property of breaking up a ray of light into two parts—double refraction this is called. When the rhomb is turned round to the extent of a quarter of a circle, the direction of the breaking up is changed from horizontal to vertical, as you may observe. The Nicol's prism, which is so constructed of Iceland spar as to cut off one of these rays, is a valuable instrument to the experimental physicist, as it enables him to obtain a bundle of polarised rays, without so much loss of light as is involved in many other cases. The rhomb of calcspar will now be handed round, together with a line negative, and you can study this phenomenon of double refraction for yourselves. As regards its crystallographic properties, carbonate of lime is dimorphous; that is to say, it crystallises in two incompatible forms: calcite belonging to the hexagonal system; and this other kind of crystalline calcium carbonate which is called aragonite, being related to the trimetric system. What is more, these two crytalline forms of carbonate of calcium differ as regards specific gravity and specific heat.

Ordinary marble consists of minute crystalline grains of calcite, while aragonite is comparatively rare. While speaking of marble, allow me to call your attention to some fine specimens of marble mosaic, lent by Messrs. Burke and Co.; indeed, you need not go far to see examples of this class of work, this institution itself affording numerous characteristic examples. Various foreign bodies contribute to the colour of different samples of marble, the foreign matter being organic, in some instances, as in the case of black bituminons marble; and in other cases it is due to metallic oxides, as, for example, those of iron or manganese.

Some of the specimens of the so-called oölite limestones are curious, small nodules of limestone being agglomerated together, something after the fashion of the roe of a fish. Occasionally, but not always, there appears to be a minute nucleus to each of the grains or nodules. Carbonate of lime is often associated with carbonate of magnesia; the proportion of carbonate of magnesia varying from nothing up to over 90 per cent. The magnesian limestones are called dolomites, and some of them form valuable building stones, excellent qualities coming from Yorkshire, Nottinghamshire, and other districts.

Various sea-shells consist of calcium carbonate in a high state of purity, and Mr. Jacobs, of Houndsditch, has lent me the greater part of the fine collection of shells which stands on the side-table. The extreme beauty of some of these shells rivals that of the most delicately formed flowers, while the great hardness and strength of the material of many shells fits it for use in making buttons, studs, and other articles; a selection, illustrating these matters, being also on the table. Pearls also consist of calcium carbonate.

A few words as to the most notable impurities with which calcium carbonate is associated in nature.

Silicon dioxide, or silica, frequently occurs in the crystalline form as grains of quartz; but in many cases, it is met with in combination with a portion of the lime, forming a calcium silicate.

Clay is almost invariably present to a greater or less extent, except in colourless or transparent specimens of calcspar and aragonite. When present only to the extent of one per cent., it does not exert any material influence on the commercial value of the carbonate of lime; at any rate, as regards the general applications of the mineral; but when, on the other hand, clay is present to a considerable extent, this impure carbonate of lime receives the name "marl," or marly limestone. When a considerable proportion of clay exists in a limestone, a notable proportion of iron is usually present, and in some cases traces of manganese.

Iron appears to be universally present, to a limited extent, even colourless calcspar and aragonite containing traces; while some samples of limestones and marbles contain a very large proportion.

Manganese is not unfrequently met with, some kinds of marble owing their colour, in great measure, to the presence of this mineral. Its occasional occurrence in certain marls has already been referred to.

Magnesia, in the form of carbonate, is an almost constant impurity, but the proportion is often as small as 0·1 per cent.; while, on the other hand, it frequently reaches 95 per cent. Such a mixture as the latter would be regarded as a carbonate of magnesia, and would go by the name of "magnesite."

Phosphoric acid is a less constant impurity than magnesia, although frequently met with.

Alkalies, especially soda, are frequently present in small proportion; but a double carbonate of calcium and sodium, which contains molecular proportions of each carbonate has been found.

Bituminous matter is very frequently associated with calcium carbonate, while various materials of organic origin are contained in ordinary chalk, most marls, shells, coral, and also in numerous other forms of the calcium carbonate.

Calcium sulphate is not unfrequently associated with the carbonate, and the presence of a small proportion of sulphate has not an extremely important influence as regards the industrial uses of the mineral.

Those limestones which contain organic impurities naturally lose them when they are burned with free access of air, as in a muffle, for instance; and when these samples of shells and black marble are burned in this gas muffle, a perfectly white lime will be obtained, as you will see if you look at them after the lecture is over. The prismatic colours of many shells are due to a diffraction of light, owing to the ridged nature of the surface. A similar effect is produced, as you may see, by this piece of glass, on which a number of parallel lines have been ruled by the means of a diamond point.

Carbonate of calcium, or carbonate of lime, may readily be obtained in a state of purity by precipitation. Here is a cold, and somewhat diluted solution of calcium chloride, to which will be added a solution of sodium carbonate. You see that a white precipitate of calcium carbonate falls; and at the instant of precipitation this is amorphous, or devoid of crytalline form. It will, however, slowly change to calcite. If the precipitation had taken place at a low temperature, say 1° or 2° Centigrade, the precipitate would have carried down six molecules of water of hydration; but if, on the other hand, these hot solutions are mixed, a precipitate is thrown down, which posesses the crystalline form of aragonite; but which slowly changes to calcite. The formation of aragonite is favoured by the presence of organic matter, or of traces of strontium.

Carbonate of lime, as obtained by precipitation, is a tasteless and somewhat inert white powder, and it is readily decomposed by ordinary acids, with the liberation of carbon dioxide. Here we have a bell jar containing some lumps of carbonate of lime in the form of marble, and you see that on pouring in some dilute hydrochloric acid, an immediate evolution of carbon dioxide takes place, this gas filling the upper part of the bell jar. A taper introduced therein is immediately extinguished, and a small gold-beaters' skin balloon filled with air floats on the surface of the heavy carbon dioxide.

Calcium carbonate is practically insoluble in water, one part of the salt requiring 10,000 parts of cold water for its solution; but the liquid possesses a feeble alkaline reaction to litmus paper. At a moderate red heat, carbonate of lime is decomposed into quick lime and carbon dioxide, provided that certain conditions are complied with; but if heated to redness under pressure it fuses, and on solidifying, forms a mass resembling marble.

Here is some lime-water, or a saturated solution of lime in water. You notice that at the present time the solution is quite clear and transparent, but on passing a stream of carbon dioxide gas through it, a white deposit of calcium carbonate is immediately thrown down. At a certain point, we may consider that the whole of the lime is precipitated in the form of carbonate, a minute quantity, corresponding to the solubility of carbonate of lime in water, remaining in solution. Let us, however, continue to pass the stream of carbon dioxide gas, and it will be seen that the carbonate of calcium begins to redissolve, it being soluble in an excess of carbon dioxide (or carbonic acid). Notice now, if you please, the effect of boiling some of the solution of carbonate of lime in excess of carbonic acid. You see, that the carbonate of lime is re-precipitated, or thrown down, as when the excess of carbon dioxide is driven off by heat, the water can no longer hold the carbonate of lime in solution.

This experiment gives a clue to the way in which many nearly pure varieties of calcium carbonate occur in nature. Water, containing carbon dioxide, comes in contact with impure calcium carbonate and dissolves a portion of it; and when this calcarious water is exposed to conditions favourable for the separation of the excess of carbon dioxide, the carbonate of lime is deposited in a state of comparative purity.

It often happens that the presence of an old tree-stump will cause the production of a deep hole in a chalk rock, as the oxidation of the vegetable matter charges the water with carbon dioxide; and the continually exerted solvent action by this carbonated water produces a notable effect in the course of time.

There is an important compound which is intermediate between the usual carbonate, and lime, and which may be called the orthocarbonate. It contains

$$Ca_2CO_4 + x\,Aq.$$

This compound is formed when slacked lime is exposed to the air, and it hardens when mixed with water; moreover it possesses considerable importance in relation to mortars and cements.

The miscellaneous uses of carbonate of lime are very numerous. Here, for example, is some whiting—a fine form of chalk—which is prepared by elutriating and washing chalk. When this is mixed with linseed oil, it forms putty—a cement which is of especial value to the glazier.

The prepared chalk of the pharmacist is merely a carefully-prepared whiting, and here are samples scented and coloured for use as face powder.

The important lithographic stone consists of carbonate of lime; here is a stone which was printed from in this room on a former occasion.

The use of carbonate of lime in the soda process of Le Blanc may be taken as an example of its use in many important chemical industries; but the principal use of carbonate of lime consists in its employment as a source of lime for building purposes. Chalk is often used to rub on surfaces with the view of increasing friction, as, for example, when a tight-rope dancer chalks his boots, or a billiard player chalks the end of the cue with which he drives the ball. The leather facings of the wind chest of an organ are often chalked, in order to diminish the tendency of the air to escape, and Mr. Barker has just arranged an experiment to illustrate to you the greater effectiveness of chalked leather over plain leather in preventing the escape of wind from a concertina.

Next week your attention will be directed to lime and its uses.

JUVENILE LECTURES.

RECENT WONDERS OF ELECTRICITY.

By W. H. Preece, F.R.S.

Lecture 1.—*Delivered on Wednesday evening, 28th Dec.*, 1881.

I ought to commence, if I carried out the customary practice, by addressing the audience as ladies and gentlemen, but to-night I much prefer commencing with boys and girls, because the two lectures that I am about to deliver to you are really intended to be addressed to the youngest members of the Society. I would first direct your attention to the fact that this hall is illuminated by electricity, and, although I do not intend in any way to refer to the electric light to-night, it is my intention, step by step, to lead you up to it, so that when we part this day week, I hope and trust to be able to let you depart with a thorough and complete knowledge how electricity works and how it produces these marvellous effects. To accomplish this object there are two things most essential; the first is, that I, your lecturer, should be perfectly clear in my definitions, and simple in the language I use; the second is, that you should devote to me your very earnest and best attention, and strive all you can, by thought afterwards, to understand what I mean. I shall use, doubtless, unconsciously, a great many words that are new to you, but which are to me just as familiar as household words. I will, however, try to explain them, and endeavour if I can, to let those words impart to you the very idea that they conjure up in my mind. At the commencement, there are two words in very common use that many of you have heard over and over again, but which convey in the way I shall use them, perhaps a different conception. These two words are "work" and "energy." I can readily imagine that one of you boys may say, when I call your attention to the words "work" and "energy," "Why, what nonsense to talk to me about work; have I not been working as hard as ever I can during the past term to gain a prize, and have not I exercised all the energy I possess to distinguish myself in my class?" But the words "work" and "energy" applied in that sense are applied in a mental sense, and not at all in the physical sense in which I shall use them. Now, I dare say many of you live in town; some may live in the country; but whether you live in town or country, you all know what a garden is, and what a gardener does. Suppose a gardener, with a ton of gravel in front of him, were told to move that gravel to a height of three feet. He would go to work with his spade; he would move shovelful after shovelful from the ground line up to the three-feet height, and after he had moved the whole of it you might readily imagine that he would be a little fatigued. Now, whenever a person does anything which causes fatigue, he does what we call work. The gardener, in lifting the gravel, would perform an amount of work which is capable of being measured. I will give you another illustration. Supposing some of you boys were put beside a pile of cricket balls, and for a wager or prize you were called upon to throw the balls as fast and as far as you could. A good thrower would perhaps throw the first ball 80 yards, he would throw the second ball 75 yards, the third 70 yards, the fourth 65 yards, and so each ball that he threw would go a less and less distance, until he had no strength left, and he could throw no more balls. Now, that boy would have done work; something would have passed out of him into the balls; he has, as it were, passed something that belonged to him into the cricket balls, and as a result he feels fatigue through the loss of this something. Take another illustration: Supposing two crews agree to row a race. They start full of life and full of energy; they pull with all their hearts and might and arrive at the goal, in common language, thoroughly pumped out. Something has gone out of them into the boat. That which has gone out of the crew, and out of the boy who threw the cricket balls, is what we call energy, and what they have done is to do work upon the boat. Another example is in the case of football. A boy kicks a football and makes a splendid goal. To do that he has sent something out of his body into the ball which hurtles through the air past the goal, and the game is won. In all these illustrations something is done which results in fatigue, work is performed and energy is lost; in fact, work done means energy applied, and energy applied means work done. As mental energy is our capacity for learning lessons, for going through examinations, and that kind of thing, so the energy of the kind I speak of is the capacity for doing absolute physical work. The generality of this energy is immense. It is a difficult thing to grasp the fact that there is something in existence that we cannot feel, that we cannot touch, and that we cannot see, but which gives us all the force and all the power we possess. The earth as it moves around the sun, and the earth as it daily rotates upon its own axis, are instances of the existence of this energy; in fact, every kind of change produced in the condition of matter, whether it be in its physical state or in its position with reference to fixed objects, means energy gained or energy lost. The energy gained or lost is the quantity of work done on a body, or done by that body; so I want you to grasp, if you possibly can, the fact that every case of motion on this earth—even the sound of my voice, as I now speak to you—is due to the exercise of this particular energy. Lecturing, for instance, is a considerable exercise of energy. A man can lecture pretty well for an hour; he can lecture not quite so well for two hours, but the best lecturer in the world can scarcely keep at it for three hours without losing all his energy, and, like the crew in the boat, being thoroughly pumped out. This energy — or work done, as I have said— is measurable. The gardener who moves his ton of gravel three feet high has done an amount of work that any boy can calculate who will reduce one ton to pounds, and multiply that sum by three. He will then have obtained 6,720—what we call foot-pounds. One pound, raised one foot high, is the common and ordinary unit of work; 33,000 pounds, moved one foot high, is called a horse-power, and the horse-power is the mode by which the power of steam-engines is measured. One steam-engine is known from another by its being able to exercise 10, 20, or 50-horse power; and so, whether it is merely the lifting of gravel—or a small tube, such as I have here—throwing a cricket ball, moving a boat, or working a steam-engine, it can all be measured by this simple unit of foot-pounds. Two other terms are necessary, in order to make you comprehend what energy is. Energy is found in two conditions —called "potential" from its position, and "kinetic" from its motion. The potential form of energy is that which exists in the form of a wound-up watch-spring: you wind up the spring your watch, and, by doing so, you pass something from your body into it—you transfer energy from your own body into the watch, the spring is wound up, and the watch thereby can be kept going for twenty-four hours, or more, from the storage of energy imparted to it. A clock, again, will go for eight or fourteen days by your winding up the weight until you impart to the clock energy, in this potential form, of sufficient power to keep a clock going for a fortnight. In gunpowder there exists a splendid example of the storage of energy. It remains quiescent until heat is applied, when its potential form of energy is at once transformed into its active or kinetic form, impelling a cannon-ball, or bullet, with tremendous force. Coal, again, is a grand store of energy. All our steam-engines employed in manufactures are set going by the energy that is stored up in coal. This energy has remained stored up in coal for millions of years in the bowels of the earth, it is brought to the surface, and is there used to produce power in the innumerable ways with which you are acquainted. Take food; I had a very good chop just now; that supplied me with a store of energy, which will enable me for one hour at least to talk to you, and had I not had that chop, I do not think I could have talked to you for more than half-an-hour, instead of the three-quarters more that I hope I may yet be able to get through. I have given instances of energy in its potential form. We will now take one or two instances of it in its kinetic form, that is, when it is in a state of motion. A moving cricket-ball is a good example of kinetic energy. In its passage through the air it possesses kinetic energy, and should the ball catch your head you know pretty well what is the effect. A steamship moving and a running railway train are kept in motion by the energy imparted to them from coal, and we know what tremendous energy a steamship or a railway train has, as when a collision occurs there is a terrific smash up. Our earth is another magnificent store of energy in its rotation every 24 hours; a portion of this energy it gives up in the shape of tides. Our tides abstract energy from the earth which is gradually robbing the earth of its motion, and the result is that our day is getting longer and longer. If any of you live a million years you will probably find that the day will be a minute longer than it is now!

Such being the two general forms of energy, I want next to give you two or three ideas of the forms in which this mysterious energy appears. I had intended to bring a familiar toy, a humming top, before you to show you the energy it contained when spinning; but we have other illustrations of various kinds. Take a piece of a very dangerous material called sodium, a beautiful white metal, of which I have a quantity in a bottle here, put it on a piece of blotting-paper, and then place it on top of the water contained in this glass vase; you will see that the sodium posseses energy in itself in a potential form. The moment it is brought in contact with the water, the oxygen of the water unites with the sodium, and produces the effects of heat, light and sound, the result of the chemical energy of the sodium in its potential form being brought into the active or kinetic form by mere contact with the water. Another instance. Here is the dome of a bell, which I strike with a mallet or hammer, and thereby impart energy to it, and it sets the whole air of this room in motion, and every tympanum of every ear preseut is struck by the little bullets of air that are thrown into vibration, and the result is the effect called sound. As another illustration, I will take coal. I take a small piece of coal and warm it in an iron cup, so as to cause it to give out a little kinetic energy in the shape of heat, and on placing it in this jar of oxygen [experiment performed], you see that the mere insertion of coal, slightly heated, in an atmosphere of oxygen, produces a most brilliant effect, which is the result of the conversion of the potential energy existing in the carbon, or coal, into the kinetic energy seen in the shape of motion, heat, and light. We have even more brilliant effect of this conversion of potential into kinetic energy. Here is a piece of magnesium wire which, when heated [light applied] has its potential energy converted into kinetic energy, and a most brilliant light is the result. But we need not go to light, and we need not go to heat, for instances of energy. I have shown you that energy is a form of motion, that it is so found in sound, heat, and light, but we also have energy as magnetism. There is a little toy-duck floating on the basin of water before me, and I merely hold in front of it a magnet, when you will see that a sort of affection is set up between the duck and the magnet, by the duck following the motion of the magnet round the basin. That is another form of energy. The last form of energy that I wish to draw your special attention to, is that due to electricity. You have all seen the vivid flashes of lightning and have heard the dreadful roar of thunder; in those two effects we have energy. It is in its potential form when it exists in a charged cloud, and in its kinetic form, when that charged cloud gives its charge up to the earth, and in flying to the earth produces that dreadful effect that we call lightning, with its accompaniment, the roar of thunder. Thus, you have illustrations of energy in its different forms, electrical, magnetical, chemical, heat, light, and motion.

Now comes the question—how is this energy transferred from place to place? You may have all stood upon the sea beach and have seen the waves dashing upon the rocks, and sent up in the air in white and brilliant spray. You have seen the waves rolling over and over again in glorious breakers upon the sands. You have probably seen wrecks dashed to pieces by the force of waves, all which effects are the result of energy which has been imparted to the water by a storm miles and miles away, the energy of that storm having been transferred by the waves of the water till it meets with the resistance of the shore, and produces those effects I have mentioned. Again, energy is transferred by air vibrations. The explosion of a gun can be heard to a distance of 20 to 25 miles; and instances are known where the bombardment of a town has been heard at a distance of 100 miles. It is well known that the roar of the cannon at Waterloo was heard on the English coasts, at a distance of over 100 miles. Again, we have energy transferred from the sun to the earth by that thin, almost immaterial, subtle, medium, called the ether, by means of which we have motion transferred from the sun to the earth, which gives us at one moment light, at another moment heat, and at a third moment those effects that result in photographs. Energy is also transferred through matter in the shape of heat. I touch the lamps before me, and feel them warm because the heat of the incandescent material which they contain has thrown the molecules of the covering glass into vibration, and that vibration imparts a vibration to my hand that gives the sensation of heat; and if I were to put a poker in the fire—which, no doubt, all of you have done—it would be found, in a very short time, that the heat of the fire had been transferred through the poker to your hand. Electric currents are a form of energy which is driven through matter. Electricity is transferred, principally, through metals; some of them transfer it with great alacrity—for instance, silver and copper. There are, on the other hand, materials such as dry wood, glass, gutta-percha, india-rubber, and such like, that scarcely will allow any electrical energy whatever to pass through them; and the result is that bodies are divided into two classes, the one called *conductors*, that conduct electricity away, and the other called *insulators*, which prevent electricity from being conducted away. If you have noticed the telegraph wires passing through the country, you will have seen that they are suspended on little earthenware knobs (there are specimens of the various kinds in use on the table for inspection), which are employed because they resist the passage of the electrical energy through them; and, consequently, the electrical energy must flow through the wire which they suspend to the distant end, where it is wanted to do work and produce desired effects.

We have now to consider the motive agency. I ought to have said at the first starting, as every boy fresh from school will know, *ex nihilo nihil fit*, from nothing nothing is created, and therefore there can be no effect without its cause. There can be no wind without a difference of pressure in the atmosphere to cause motion of the air. At the present moment I can feel a draught, which is due to a higher pressure above and a lower pressure below on the other side of the door, and the air is circulating over my head from the higher to the lower pressure. The chimney draughts are produced in a similar manner. Why are meteorologists able to tell us that there is a gale coming? because they know that there is a higher pressure at one spot than there is on another; and where there is a difference of pressure there must be motion of air. So with water at different levels. The tendency is to produce a common level, and the passage of water from the higher to the lower level produces motion and energy. Tides are simply the result of the effort to produce equilibrium in the sea after it has been attracted in different directions by the force of the sun or the moon. Rivers flow because the water high up in the mountains is at a higher level than the ocean, and the purpose of their flowing is to produce equilibrium, or an equality of level. Heat circulates in our rooms because a higher temperature exists in the fire than in the walls. In the electric lamps before me there is a very high temperature, because the carbon is maintained in a very high state of incandescense, and on the approach of my hand, which is of a lower temperature, towards the lamp, instantly there is a passage of heat from the high to the low temperature, and I feel that heat striking my hand exactly in the same way that I feel the draught (before-mentioned) on my shoulders. Lastly, take electricity. We cannot speak of the level of electricity; we cannot speak of the pressure of electricity, in the same sense that we can speak of the pressure of liquids. We cannot speak of the temperature of electricity; but there is a peculiar condition of electricity analogous to all three, analogous to pressure, temperature, and level, and that peculiar quality or condition is called potential. When we speak of electricity of a high potential, it has exactly the same meaning as high level of water, or of high temperature, and wherever two differences of potential are produced, separated by a conductor, electricity flows. Having said so much, perhaps too much, I want to speak to you about the production of electricity. Having shown you the various forms of energy, how it is transferred, and why it is transferred, I want now, to say something of the production of electricity. You know very well that a lump of coal is a store of energy; that is evident by placing it in the fire. There are certain contrivances by which electricity can be produced from coal, but the effects are difficult to show to an audience. So we will take zinc which, for the purpose, is better than coal. Zinc is a grand store of energy in its potential form. Here is a piece which I take up and place in a glass jar, and in that same glass jar I put a piece of carbon. I then place water in the jar, and if I added to the water a little sulphuric acid, I should produce a galvanic battery; there would be a difference of potential, of which I just spoke, between the zinc and the carbon, which leads to the production of a current of electricity when the zinc and carbon are joined by a conductor. I have 40 of these cells, or a battery, downstairs, and I have two wires connected with its two ends, now in my hands. I know my battery is all right because, you see, when I bring the ends of the wire into contact with each other sparks are produced, which show that electricity is passing. I will not explain those sparks to you to-day, because I wish to talk to you about electro-magnetic effects of electricity and how they are utilised. The first is the production of magnetism. I have here an electro-magnet, which is simply a bar of iron enveloped by an insulated copper wire, and a poker. A poker can be utilised for a great many purposes, but my present purpose is to place it on the large electro-magnet before you. So long as the battery wires are not joined to the wire around the electro-magnet, and, consequently, no current is passing, you see that I can raise the poker from its position without difficulty; but, now I join on the wires connected with the battery to the coil of the electro-magnet, the poker is attracted with greater force than my strength can overcome. The effect is more perceptible by the use of nails instead of the poker. When the current is on you see that, owing to the attraction of the nails by the magnet, I am able to build up an ornamental triumphal arch of nails, but directly I take off the current, the magnetism ceases, and the nails succumb to the force of gravity, and fall to the floor. I have here the parts of an electro-magnet disjointed, which I will put together to illustrate the utility of this power of attraction. I place the iron bar surrounded with wire on the table, and on holding nails to it, you see it possesses no attractive power. If I let the current pass from the battery through the coil, the iron is magnetised, the attractive action is immediately set up, and the nails are attracted. Now, suppose I want to utilise this power to ring this bell—the dome which I struck a short time ago—I place the hammer (which is attached to a piece of iron in position to be attracted similar to the nails, so as to imitate the motion of my wrist) in front of the electro-magnet; I then place the bell-dome on its rod, so that the hammer, when drawn forward, will fall upon it; and, as you will see, the arrangement is complete in that simple form, for each time a current is sent the iron armature is attracted by the magnet bringing with it the hammer which strikes the bell by its forward motion. This is the principle on which all electric bells are constructed. A similar arrangement is employed for giving alarms in case of burglary. A small switch arrangement is attached to the framework of the bedroom door [a small door so fitted was exhibited]; this switch is put on on going to bed, and should the door be opened by anyone during the night, a succession of currents of electricity are sent to a bell, which continues to ring till attended to, and it would be a bold burglar who dared to carry on his nefarious business under such a din. A modification of this arrangement can be adapted to innumerable purposes. In America, where servants are not so plentiful as in England, necessity has compelled the employment of electricity for domestic purposes, to a far greater extent than in England. In nearly every town in America, systems of wires extend to almost every house, in the hall of which is a small instrument [one was exhibited], on the dial of which divisions bear the various words—messenger, carriage, coupé, express waggon, doctor, police, fire, and two or three other things, and on turning the instrument pointer to any division, and drawing down a spring, a call is sent to the central-office or bureau, and the instrument there indicates the service required and at what house, and the request is carried out at once. While travelling in America, I was once afraid that I should not have time to reach the nearest telegraph-office, to despatch a telegram in reference to an appointment; and on mentioning my concern to the lady in whose house I happened to be, she put her little instrument to "messenger," sent the current by pulling down the spring, and in two minutes a messenger was at the door waiting to convey my message to the telegraph office. Time passes terribly quick, and my energy is gradually disappearing, so that I shall have to pass over some of the things I wanted to show you, such as the process of engraving by the electro-magnetic system; how toys were moved, boats made to swim about, and birds to sing. At the recent Paris Exhibition, the varied applications of electricity were simply wonderful and amusing. I have no doubt we shall have a great many of them exhibited, shortly, at the Crystal Palace, where I hope some of you may be able to go before your return to school. I will now show you how this system of producing electro-magnetism can be utilised for telegraphic purposes. On the table are fixed two complete sets of telegraph instruments, very close to each other, but the set on the right hand belongs to one station, and that on the left hand to another station. You may fancy that the instrument which I touch, on the left, is in London, and that which Mr. Cordeaux touches, on the right, is in Liverpool. For every current of electricity I send from London, I do a little work in Liverpool, and that results in motion, producing sound. The mere depression of my "key" produces electro-magnetism in Liverpool which attracts a piece of iron and produces a sound. [Illustrated by working the instrument.] The battery attached to my key is in London, and the depression of my key sends on a current which arrives at Liverpool, produces magnetism and sound. By depressing the key rapidly or slowly the sounds may be made correspondingly short or long. [Illustrated.] By an arrangement of dots and dashes, the letters of the alphabet are represented, and experienced clerks can read off the sounds and translate them with astonishing rapidity. To illustrate this to you, I will ask your Secretary to write down a short sentence, unknown to my assistants, which shall be sent by one of them, Mr. Cordeaux, on one instrument (supposed to be in Liverpool), and read off by Mr. Cooper on the other instrument (supposed to be in London). [The Secretary then handed in a slip of paper to Mr. Preece, and the message it contained was read off by Mr. Cooper, "A Merry Christmas to the juveniles."] That is the operation of telegraphy. The sounds are read off as clearly as ordinary spoken language, though mistakes are sometimes made. For instance, a party of young school girls, out for an excursion once, wished to advise their schoolmistress of their safe arrival at a certain point, and sent the message, "arrived all right;" but the schoolmistress was horror-stricken to read the message as delivered to her, which read "arrived all tight." Telegraphically, the difference between the two messages is not great, for the letter *R* is represented by two dots and a dash, while *T* is represented by a dash. Another error in transmission was where a message, "Five fathoms and four feet is ample for my wants," was delivered "Five fat sows and four feet;" a cricketing message from Lord's, "Jack, bring up two ground men," was delivered "Jack bring up £2 10s." And at the time that Commodore Goodenough was appointed to a station in Australia, the message received was "A commodore has been appointed good enough for the Australian colonies." The system of telegraphy I have just shown is the ordinary one-way method; but it is possible to send two messages in the opposite direction at the same time upon one wire, and this I can make clear, without going into a detailed explanation, by asking Liverpool to send dashes or long sounds to me while I send dots or rapid sounds to him. [This was done.] We go still further, and send four messages in opposite directions, at the same time upon one wire, that is called quadruplex telegraphy. But the acmè of telegraphy has been produced in this country by the Wheatstone automatic apparatus. I have a complete set of this apparatus before me. In it the messages are prepared by being punched with little holes (as you now see being done), and I now hold a slip of paper bearing perforations representing the alphabet, which look very much like the patterns used in the Jacquard loom for lace-making. The perforated paper is put in the transmitter, which sends on currents of electricity, representing the holes upon it; these currents of electricity are received by a "receiver," by which they are made to represent dots and dashes recorded on a long slip of green paper, and these dots and dashes indicate to the clerk at the receiving station the message sent. The peculiarity of this instrument is its rapidity, for, by it, instead of being only able to send from 30 to 40 words a minute (the limit of the human hand) from 250 to 300 words a minute can be transmitted. At the present moment, there is not a town in this country where a daily paper is published, that is not in direct communication with London, and receives its intelligence by means of apparatus of this description. Whatever news it is, whether an account of the Canonbury railway accident, or a panic that may have happened this afternoon in some theatre, or something else now going forward to the country papers, it is being sent by means of this perforated paper and automatic instrument Those who are interested in the apparatus will be able to examine it closely at the end of the lecture; but it is impossible for me to describe it minutely now, because it would occupy more than one lecture to understand the whole working of the system. It is most extensively employed in this country, where the growth of telegraph business has been enormous. I spoke in rather glowing terms of the duties and doings of this automatic apparatus when in Paris, and my Parisian friends rather doubted my statement. However, I induced the French Government to send an officer over to Eng. land to examine for themselves the working of this instrument, and to my great pleasure when he came here he found that my statements were under the mark, and only a few days ago, when an experiment was tried, to satisfy the French gentleman, we were able to transmit on a wire between London and Glasgow, no less than 352 words a minute. The growth of telegraphy in this country has been enormous. In 1869, there were only 2,000 offices open, there are now 5,500; there were then only 6,000,000 messages sent a twelvemonth, there are now 30,000,000; the income in 1869 was £700,000, it is now £1,600,000; the number of newspapers and clubs supplied with news was then only 173, it is now 803; and there are 326 towns now being supplied with news direct from London. In regard to submarine cables, I have here a box of specimens of the various types of cable laid down, which is well worth examination. Submarine telegraphy has increased during the ten years, from a few hundred miles of cable, to 70,000 miles, which now engirdles the world. There are many other applications of electricity besides telegraphy, such as, for instance, railway signals. A railway accident recently occurred at Canonbury where three or four trains were huddled up in a tunnel. I do not know much about the system of signalling used on that railway, but I know a good deal of the system of signalling in use on the London and South-Western Railway and other lines. The principle of the "block" system is simply that a railway is supposed to be divided into certain sections of a given length, and no two trains are allowed, or ought to be allowed, to be in one section at the same time. If, for instance, the section be a tunnel, such as at Canonbury, and two trains are allowed on it, the risk of collision is great, as recently proved; but if the block system be thoroughly and efficiently carried out, there ought to be no such accidents. Some twenty years ago, after a good deal of talking, writing, and persuading, I induced the London and South-Western Railway to adopt the block system. The system in use on the London and South-Western Railway is my own. A complete set of apparatus is before you, and I will explain its working. A little semaphore is in front of the instrument, which, when down, indicates that all is clear, and when up, that there is danger and the train must stop. Suppose the instrument near me is at Waterloo Station, and the other one near Mr. Goldstone is at Vauxhall. That represents a section of the railway, upon which we want to allow one train only at a time. To ascertain if all is clear to Vauxhall, I send a warning signal of two beats given twice, indicating "A train is coming," which is acknowledged by a signal of one beat from Vauxhall; my semaphore arm is down, telling me that the line is clear, and I let the train go on, sending a signal of two beats [this was done] to Vauxhall, to tell him that the train is in. Vauxhall raises the semaphore behind the train to prevent me from sending on another, and I acknowledge his signal, by giving one beat of the bell. The train is now proceeding; the semaphore arm at this end is up, protecting the train, and I cannot, I dare not, send another train until I know that the one now going on has arrived at Vauxhall. It is now supposed to have done so, and he sends three beats upon the bell, which lowers my semaphore arm and tells me "Line clear," and that the apparatus is in working order. On such a system the traffic of a railway can be conducted day by day, and hour by hour, with safety to the public, and with satisfaction and certainty to the railway interest. One other illustration that I must give you, of the application of electricity, especially as my store of energy is not yet exhausted, is the telephone. One of the most beautiful things at the Paris Exhibition was the transmission of music, by means of the telephone, from the Opera House to the Exhibition building. At the Opera House several microphones were fixed upon the stage, and at the Exhibition building telephones were fixed in rooms into which visitors could go, and, by applying the telephones to their ears, could listen to the overture of the orchestra, or the singing or talking of the performers, as also the hum of the ballet-girls behind the stage. The effect was something startling. I remember one night seeing a Frenchman put the telephones to his ears, and the moment he heard the sounds he threw down the instruments, and rushed out of the room, saying, "*c'est terrible, c'est terrible!*" The Christmas holidays have prevented my having similar arrangements for this lecture, and the best thing I could get ready is a telephone circuit between this Hall and a neighbouring room. I will call up and ask my assistant to play something on a cornet. [The cornet was heard playing quite distinctly.] That is an instance of what I wished to illustrate to you at the commencement; we have a bugler, full of energy, who blows into his bugle, the energy of which takes the form of sound; the sound waves, or vibrations, strike the top of the telephone case, and set a microphone in vibration, which causes currents of electricity to pass along the wire from the instrument at the other end to the one before you. In the receiving instrument the currents sent by the microphone take the form of electro-magnetism, and reproduce the vibration of the microphone upon a disc in front of the electro-magnet, and so we get reproduced in the same form the energy set in motion at the other end, after having passed through various stages. The motion of the cornet is transferred, first, into the motion of the disc, then into the electrical form of energy, then into that of electro-magnetism, then back again into motion, and, finally, to your ears; and you will easily understand from this that electric currents are merely one form of energy. I intend to pursue this subject next time, and show you how electricity is produced in other ways, and how it breaks up chemical compouds with their separate parts; how electro-plating and silvering is done; and finally I will show how it produces the beautiful Edison electric light we now have in this room. The elegant chandelier now illuminating this room was made especially for exhibition at this lecture, and was prepared by Messrs. B. Verity and Sons of King-street, Covent-garden.

Miscellaneous.

COALFIELDS OF SWEDEN.

The following particulars respecting the coalfields of the south of Sweden, situated in the province of Skane, Scania, are taken from an article in *Iron*:—

The Kropps Company have on their property—borings having taken place to a depth of 632 feet, at different points from 94 to 612 feet—struck not less than thirteen seams, from 1 inch to 8·25 feet in width. The deposits have, by the different geological surveys effected, been ranged into four districts, viz.: Engelholms district, with an extension of 56,000 feet, and an average width of 20,000 feet, with a surface cubit of about twelve hundred million cubic feet; Helsingborgs district, extending some 109,000 feet, and an average width of 42,000 feet, the surface cubit being five billions and a half; Trollenäs district, with a surface cubic of six and a half million cubic feet; Rödinge district, extending 40,000 feet, with an average width of 3,500 feet, a surface of about one and a half million cubic feet. The total cubic surface of the Scanian coal deposits is thus estimated at seven billions of cubic feet. Over this surface the following coal mines have been opened:—

1. Höganäs, with five different seams. Of these, only two have been found worth working, and one only has been worked lately. This mine, which is situated on the shore of the "Sound," was opened in 1796, and a company formed for its working, which, in order to further the undertaking, appointed an Englishman, Thomas Stawford, from Newcastle, chief superintendent, and one of the galleries still bears his name. The subterranean galleries now extend about 9,000 feet north and south, and 7,000 feet east and west, with a surface area of 63,000,000 feet, equal to 1,350 acres. There has here, from the year 1797 to 1876, been raised 74,057,788 cubic feet, which, at 20 öre (2¾d.) per foot, represents a capital value of kr. 14,811,557, equal to £825,000, making a yearly average of 925,722 cubic feet. From 1856 to 1865 16,000,000 cubic feet, or an average of 1,316,875 cubic feet a year, were raised, and from 1866 to 1875 16,000,000, or about 1,587,765 cubic feet yearly, were raised. As this coal mine has been one of the most promising in Sweden, the Crown, in order to encourage this industry, has not only granted the company working this mine several privileges, as exemption from taxes, &c., but entered even for a time on a policy of protection by imposing a duty of 5d. on every barrel or tunna (8½ to a ton) of coals imported from England, and of which duty the Höganäs Company received about 4d. as a bounty. In spite of this the concern has made comparatively little progress, although a bounty was later on granted by the Crown to the company for every tunna of coals produced; the above duty on English coals during that time, however, to go to the treasury. From the returns of the company it appears that from 1797 to 1817 there were put out 1,754,482 tunnor, equal to about 220,000 tons, which is a yearly average during these years of 83,547 tunnor, or nearly 10,000 tons a year, and of which quantity some 25,000 tons were shipped for abroad. It may be interesting to observe how our own coal trade has at times affected that of Sweden, and we therefore take the figures from the company's accounts during the years during which our trade was most affected, viz., from 1808 till 1816. In the year 1808, the loss amounted to £225; in 1809 the gain to £2,450; in 1810 the gain to £2,875; in 1811 the gain to £3,010; in 1812 the loss to £860; in 1813 the loss to £1,412; in 1814 the loss to £1,600; in 1815 the gain to £240; and in 1816 the gain to £630. It has on several occasions been proposed to the Swedish Parliament to purchase this concern for the benefit of the country, but as yet, it seems, without success. The quantity of water which floods the mine is considerable, and two powerful engines are required to keep it under; but the water is, although the mine is situated near the sea, entirely free from salt. The output has been: 1876, 1,765,754; 1877, 2,188,172; 1878, 2,205,257; 1879, 2,265,899 cubic feet.

2. Billesholms and Wallakra bearing four seams. This mine was opened in 1865, and there was, during that year, raised 110,212 cubic feet of coals; from the year 1866 to 1875 there was raised in all 3,556,145 cubic feet, or a yearly average output of 355,614 cubic feet. In 1876, the output was 1,045,914 cubic feet; 1877, 1,253,100 cubic feet; 1878, 1,294,254 cubic feet; 1879, 1,555,530 cubic feet. Billesholms coals, like those from the Höganäs mine, are: No. 1, glance coals, compact and stainless; No. 2, glance coals, crossed by dull streaks; and No. 3, dull coals, crossed by lustrous streaks. They have been used on Swedish railways with great advantage. The Helsingborg railway, for instance, state they have found them 1¾d. cheaper per train mile than English. These coals have also been used with success for forging and smelting purposes.

3. Boserups possesses one seam of a foot's thickness, yielding coals of first and second quality only. The seam has been found to rest on a strata of lias, about six feet in depth, and runs almost horizontal; it was opened in 1866, when 9,853 cubic feet of coals were raised. From 1866 to 1875, 454,820 cubic feet were raised, of which 389,200 cubic feet were No. 1 and 65,620 No. 2 quality coals. The average output per year has thus been 45,482 cubit feet, of which 38,920 were No. 1, and 6,562 No. 2 quality coal. In

1876, the output was 61,000 cubic feet; in 1877, 54,000 cubic feet; in 1878, 55,046 cubic feet; in 1879, 71,078 cubic feet.

4. Wallakra. with a seam of 84 feet of 1·5 foot thickness, one foot of which is No. 1 coals, and 0·5 of in different quality; this seam rests also on a layer of lias. No coal-winning of any importance has taken place here, beyond what has been accounted for under Bilserholm.

5. Helsingborgs was opened as early as 1581, but regular mining did not take place here till 1870, when several shafts were driven and two seams of a foot's thickness each, one at 28 and the other at 115 feet depth were found; from 1866 till 1875 the output was 427,647 cubic feet, or an average of 42,765 cubic feet a year. In 1876 there was only raised a few thousand cubic feet, since when the returns have ceased.

6. Stabbarps possesses five seams. This mine was opened in 1867, when two of the seams yielded 119,011 cubic feet, and in 1868, 75,960 was put out out. The returns are wanting till 1873, when the output amounted to 32,800 cubic feet; from 1873 till 1875 there was put out a total of 120,936 or 40,312 cubic feet yearly. In 1876 the output was 13,153 cubic feet; in 1877, 7,926 cubic feet; in 1878, 3,798 cvbic feet; in 1879, 2,270 cubic feet.

7. Kropps has two seams, one at a depth of 118 feet, with a thickness of 1·33 foot, and another of 144 feet, 1·67 foot thick. The coal-winning commenced here in 1873, when 48,398 cubic feet were raised; from 1873 till 1875, 952,632 cubic feet were raised, making a yearly average output of 317,544 cubic feet. In 1876 the output was 632,325 cubic feet; 1877, 783,285 cubic feet; 1878, 701,440 cubic feet; and in 1879, 799,799 cubic feet.

8. Skromberga, where two seams have been worked from 1876, with this result. In 1876 there was put out 174,678 cubic feet; 1877, 201,954 cubic feet; 1878, 170,064 cubic feet; and in 1879, 189,624 cubic feet. Besides the above eight mines, there are a few others, from which has been won, from the year 1864 till 1876, in all 7,643,290 cubic feet, which, at a rate of 20 öre (2¼d.) per foot, realised about £85,000; the working then ceased, however, from want of capital. The total output of coals from the Scanian fields, from the opening of the Höganäs mines in 1796 till 1879, has been about a hundred million cubic feet, representing a capital value of £1,100,000 In the year 1875, which will stand as a fair average one, the importation of English coals was about 36,000,000 cubic feet, which, taken at an average value of 30 öre (3¼d.) per foot, represents a capital value of nearly half a million sterling. Within the districts of Engelholm and Rödinge, no mines have as yet been opened, but borings at great depths have revealed seams of great richness.

Professor Erdman, of the Royal Swedish Geological Association, has, from a scientific survey of the coalfields of Sweden, estimated these deposits in Scania at seven and a quarter billion cubic feet, and has also, by careful calculation, estimated the actual coal deposits to represent a value of 145 millions sterling. It may, therefore, easily be conceived of what extreme importance this question is to the country, which, furnished with a fair supply of coals only, might become our most formidable competitor in the world's supply of iron and steel. The coalfields of Sweden were known to exist as early as the sixteenth century, and were the first coals used at the beacon of Kulla, the dark promontory of which, during the day, scowls threateningly upon the beholder, but which is, during the stormy equinoctial night, the faithful guiding star of many of our brave sailors bound for the tempestuous Baltic. King Frederick II. of Denmark, to whom this province then belonged, granted in an open letter of October 2, 1581, unto one Christopher Schonwalde, a German, the sum of 100 daler, about £12, and a "court dress," in order to ensure his attention to these coalfields. Charters were subsequently granted at different dates to companies for the working of the seams, but no progress was made to speak of till 1796, when the Höganäs mine was "inmutad." We may here call attention to the peculiar "right of inmutning," which exists in Sweden, viz., that whosoever may happen to discover a metal lode, a mineral deposit, or a seam of coals, in any part of the land, may, on obtaining a Crown license or "inmutningssedel," proceed to dig or work such deposit to his own advantage, irrespective of, and without compensation to, the owners of the soil on which the discovery was made. It is stated, in favour of this system, that such a privilege is the cause of the discovery and working of many a mine which else might be left undiscovered; but some persons have, of late years, raised a strong protest against this enactment, and have, to verify their views, pointed to England, where no such stipulation exists, as the greatest iron and coal producing country in the world.

HEATING RAILWAY CARRIAGES WITH ACETATE OF SODA.

A plan for heating railway carriages with acetate of soda, invented by M. A. Ancelin, is being tried on the railway from Paris to Havre, and also on the line from Orleans to Chalons.

This system is based upon the fact that solid bodies in passing to a liquid state absorb an amount of heat, which is rendered latent as the body is dissolved, whilst on reversing the process, and passing back to a solid state, it is evolved into an active form.

Crystallised acetate of soda, $C^4 H^3 O^3 NaO + 6 HO$, melts at 59° C. (138° Fahr.), and requires 94 calories, as by following formula :—

$$l = (160 \times t)(C - c).$$

$l =$ latent heat.
$t =$ temperature.
$C =$ specific heat of acetate of soda in liquid state $= 0{\cdot}75$.

c = specific heat of acetate of soda in solid state = 0·32.

A foot-warmer of the capacity of 11 litres (671·30 cubic inches) would contain about 15 kilogs. (33 lbs.), and supposing its initial temperature to be 80° C. (176° Fahr.) (heat of an ordinary hot-water warmer), it would give off

	Calories.
In cooling, from 80° to 60° C. (176° to 140° Fahr.)	225
Latent heat rendered sensible	1,410
In cooling from 60° to 40° C. (140° to 104° Fahr.)	96
Total calories	1,731

An ordinary warmer of equal capacity, containing water in cooling from 80° to 40°, would develop 440 calories, or only one quarter of the heat of that containing acetate of soda.

The ordinary foot-warmers requires refilling about every 2½ hours, whilst those containing acetate of soda would only require changing after 10 hours use; and besides the advantage of giving less annoyance to passengers, a considerable saving in labour would be effected, besides economy in fuel. A further saving would also be made, as the warmers, after being removed from railway carriages, are exposed to the air, and their temperature is reduced to 10° C. (60° Fahr.) before being refilled. To heat them to 90° C. (194° Fahr.), 80 calories are required per litre, so that to heat a foot-warmer 4 times, 1,760 calories are lost, and only 1,760 calories are utilised.

On the other hand, with the acetate, a warmer containing 15 kilogs. at a temperature of 10° C., would require

	Calories.
From 10° to 40° C. (50° to 104° Fahr.) 30 × 0·32 × 15 =	144
From 40° to 60° C. (104° to 140° Fahr·) 20 × 0·32 × 15 =	96
Heat expended for melting (latent)	1,410
From 60° to 90° C. (140° to 194° Fahr.) 30 × 0·75 × 15 =	337
Total calories	1,987

of which only 144 calories from 40° to 10°, and 112 from 90° to 80°, or 256 calories, would not be utilised.

The heating with water requires a storage of 3,520 calories, whilst that with acetate only 1,987. The melted acetate is introduced into the warmer at a temperature of 100° C. (212° Fahr.), which is closed hermetically directly filled, and only requires to be placed in a bath of boiling water for 1½ hours to be heated.

P. L. N. F.

INDIA-RUBBER TREE.

The way in which this remarkable tree, *Ficus elastica*, became known to botanists and horticulturists was very singular, as related by Roxburgh in his "Floria Indica," iii., p. 543. Towards the close of 1810, a Mr. Matthew Richard Smith, of Silhet, sent Roxburgh a vessel, there called a "turong," filled with honey in the very state in which it had been brought from the Pundua or Juntipoor mountains north of Silhet. The vessel was a common, or, rather, coarse basket, in the shape of a four-cornered, wide-mouthed bottle, made of split Rattans, several species of which grow in abundance in the above-named mountains, and contained about two gallons. Mr. Smith observed that the inside of the vessel was smeared over with the juice of a tree which grows on the mountains. Roxburgh was therefore more anxious to examine the nature of this lining than the quality of the honey. The turong was accordingly emptied and washed out, and Roxburgh then found that it was very perfectly lined with a thin coat of caoutchouc. Young trees were speedily procured through Mr. Smith, and cultivated in the Botanic Garden at Calcutta, where they throve with the greatest luxuriance. The name only was first published in Roxburgh's "Hortus Bengalensis" (1814), p 65. When we say name only, we mean without description, although Roxburgh indicated that it was a large tree, and gave the season of flowering and fruiting. Recently Dr. Brandis ("Forest Flora," p. 418, in a footnote) has stated that Blume must stand as the authority for *Ficus elastica*, "because Roxburgh did not include it in his 'Hortus Bengalensis,' and his 'Flora' did not appear till 1832, whereas Blume published it in his 'Bijdragen tot de Flora van Nederlandsch Indie' (1825), p. 446." But this objection fails, inasmuch as the name is included in the "Hortus Bengalensis" in the place quoted. Blume received the plant from the Calcutta garden, and published the name as his own. We sometimes find Linnæus cited as the authority for the name, but, as we have shown, it could not have been known to him.

In 1815, five years after its discovery, as we learn from Sweet's "Hortus Britannicus," 2nd ed., p. 461, it was in cultivation in this country. Its hardy nature enabling it to bear smoke, dust, gas, wet, and drought, better than most other plants, it soon became a common and favourite ornament in sitting-rooms and other parts of dwelling-houses, as well in this country as on the Continent. Although it will bear a great deal of rough treatment it repays a little care by producing leaves as much as two feet in length; but for indoor (dwelling-house) decoration it should be kept in small pots, in moderately rich soil, or it will soon outgrow its space. Indeed, it is remarkable how long this tree, which attains gigantic dimensions in a wild state, may be kept healthy and ornamental in a mere handful of earth. With regard to the size of this tree in its native country, we find some interesting particulars in William Griffith's "Report on the Caoutchouc Tree of Assam," in the *Journal of the Asiatic Society of Bengal*, vii., part 1, p. 132. In the district where it grows it overtops the other vegetation, not only growing tall, but forming colossal trunks. The dimensions of one tree measured by

Griffith were: circumference of main trunk, 74 feet; ditto of main trunk and supports, 130 feet; estimated height, 100 feet. The nature of the trunk is very extraordinary, and is thus described by Griffith:—"It differs in the first place from the ordinary trunk by its sculptural appearance, and it is from this that its extremely picturesque appearance arises. The appearance arises entirely from the tendency of these trees to throw out roots, both from the main trunk as well as from the branches, and from the extreme tendency these have to cohere with the trunk, or with each other. If the roots are thrown out from or very near the main trunk, they ordinarily run down its surface, and cohere with it firmly, and hence the sculptured appearance. If, as happens in some, they are thrown from the branches at such a distance from the trunk that they do not come into contact with it, they pass down to the earth, and form what I call supports. These supports never appear to produce leaf-bearing branches, so long, at least, as they remain attached to the tree. They are generally perfectly straight at first, becoming conical only by divisions at the apex when near the earth, and by the mutual adhesion of these divisions. Very generally it would appear this species, as well as some others, vegetates in other trees; its first processes of growth being probably similar to those of other dicotyledonous trees. The roots, however, in obeying the laws regulating their descent, soon come into contact, and wherever they do so a mutual and firm adhesion is the result. A network is soon formed round the tree; the size of its reticulations soon diminishes with the increase in the number of roots; and at last a nearly solid and excessively firm cylinder is formed, which encloses, as it were, in a case, the tree which originally protected the young seedling. To such an extent is this carried that the death of the tree is sure to occur sooner or later. In such a case as this the fig-tree has, it may be said, no trunk at all comparable to ordinary trunks, which result from growths in an ascending direction. In these they originate from the aggregation and cohesion of roots, or from growth in a descending direction." From Griffith's observation it appears that this tree rarely fruits in a wild state, and still more rarely does it fruit under cultivation in this country. An instance occurred in the garden of Mr. Boyce, of Clapham, in 1874.—*Gardeners' Chronicle.*

Notes on Books.

The Water Supply of England and Wales; its Geology, Underground Circulation, Surface Distribution, and Statistics. By Charles E. De Rance, Assoc. Inst. C.E., F.G.S. London: E. Stanford, 1882.

Mr. De Rance has been investigating this subject since the year 1873, and the present work is founded upon his papers read before the Congresses on Water Supply of the Society of Arts, 1878 and 1879, and upon his lectures on the same subject, delivered at the Wigan Mining School in 1876. The chief objects of the author have been to show the quantity of water required for human consumption in each group of river-basins as delineated in the Catchment Basins' Map of the Ordnance Survey, and by describing the area of the principal geological formations, with the amount of rainfall, to afford data for estimating the volume of water available. The first two chapters are devoted to the consideration of the rainfall, and percolation of rainfall, and the composition of water; then follow full accounts of the basins and streams of the whole of England and Wales, and the concluding chapter deals with the question of propagation of epidemics by potable water. The book is illustrated with several coloured maps.

The Peoples of the World; being a Popular Description of the Characteristics, Manners, and Customs of the Human Family. By Robert Brown, M.A., Ph.D. Part I. London: Cassell, Petter, Galpin, and Co.

This work is founded upon the author's "Races of Mankind," with large additions. The first part contains a general introduction on the progress of the human race, from the Stone Age to the present period; and an account of the Eskimo, all fully illustrated. It is proposed to follow this with an account of the everyday life and customs of the nations and tribes of the earth.

Handbook of the Collection illustrative of the Wild Silks of India, in the Indian Section of the South Kensington Museum. By Thomas Wardle. London: Eyre and Spottiswoode, 1881.

Mr. Wardle, who read a paper before the Society of Arts in May, 1879, on the "Wild Silks of India," has here prepared a handbook to the collection which was added to the South Kensington Museum in December of that year. In addition to, and illustrative of, the classification of silkworms, the description of various processes of reeling, spinning, dyeing, and printing Tusser silk, &c., there are a series of sixty-six plates, showing the moths, larva and cocoons, leaves of plants, vessels, brushes, and machinery used in processes of manufacturing the silks, and maps of India showing the districts frequented by the Tusser, Eria, Mungar, and Atlas moths.

Suggestions for a great International Exhibition of the Industrial Arts, Manufactures, Fine Arts, Scientific Inventions, Discoveries, and Natural Products of all Countries, to be held in Manchester, in the year 1882. By Ellis Lever. Manchester, 1881.

Mr. Lever (who was greatly assisted by Mr. George Howell in the work) has given in this pamphlet a history of the rise and progress of Industrial and Art Exhibitions, from their origination in France, in 1797, and he points out in each case the important influence of these exhibitions on the prosperity of the countries which foster them. The conclusions at which he arrives, after thoroughly investigating the subject, are (1) that the local and special exhibitions have seldom failed; (2) that national exhibitions have, as a rule, been highly successful; and (3) that those international exhibitions which have been organised on a scale of great magnitude, have nearly always been a gigantic success. The author strongly urges the organisation of an exhibition at Manchester on a plan which he sets forth.

Obituary.

ROBERT CALVERT CLAPHAM, F.C.S. — Mr. Clapham, a well-known chemist, of Earsdon-house, near Newcastle-upon-Tyne, died at Winchelsea, on the 22nd December, 1881, aged 58 years. He was elected a member of the Society in 1874, and he has been since that time a frequent attendant at the meetings and a speaker in the discussions. He was appointed examiner on the alkali manufacture in the Technological Examinations of the Society of Arts, when in 1875 this subject was first added to the programme of examinations. When the City and Guilds of London Institute took over the Technological Examinations of the Society, Mr. Clapham continued as examiner to the new Institution. Mr. Clapham was the author of several papers on chemical and chemico-geological subjects in various scientific journals, both alone and with other writers. The first of these was on the "Theory of the Formation of Sulphur in Volcanic Countries," published in the "Transactions of the Tyneside Naturalists' Field Club" (iv., 1858-60). Other papers appeared in the Reports of the British Association in the *Chemical News*, *Geologist*, and other journals.

General Notes.

NEW MUSICAL INSTRUMENT.—According to the *Palestra Musicale* of Rome, Signor Lasina has invented a new musical instrument, which he calls the *Legnophone*, resembling the *Madera y paya*, so well known in Spain. This instrument, on the perfecting of which Signor Lasina has worked for years, is in the shape of a triangle, and consists of forty-five small rods of white poplar wood, lying each one on six short straws standing on a plank of deal. The musician strikes these rods with two sticks, as if they composed the key-board of a piano, and plays with ease and accuracy the most difficult pieces of music. Signor Lasina intends to give a series of public concerts to introduce his *Legnophone* to the notice of amateurs.

ELECTRIC CLOCKS.—A system of electric clocks has been organised for Genoa, and is now being carried into execution. The clocks will be arranged in five distinct lines, all branching out from the Municipal Palace. The first, with seven clocks, will extend to the Porta Lanterna; the second, with nine clocks, to the Molo Vecchio; the third, with nine clocks, to the Carignano; the fourth, with nine clocks, to the Palazzo Tommaseo; and the fifth, with five clocks, to the Piazza Manin.

PENCIL SHARPENER.—Mr. B. S. Cohen has lately brought out an improved apparatus for sharpening pencils. It is constructed of thin steel, formed in a shape to correspond with the shape of the pointed pencil, one edge of the steel being formed so as to act as a cutter. The sharpener is formed in various sizes to suit different pencils. It is specially intended for pencils made with round leads, which are now being manufactured extensively. A special sharpener is made for use with coloured pencils.

COPPER IN THE UNITED STATES.—A return issued by the Department of the Interior, Washington, states that during the census year, ending on 1st June, 1880, 50,655,140 pounds of copper were produced in the mines of the United States, east of the 100th meridian. The product was valued at $8,842,961, and the wages paid to workmen, &c., reached $2,915,103. The capital of the various companies concerned amounts to $31,675,096.

A NEW PHOTOMETER.—A simple form of photometric balance has been invented by M. Coulon, who calls it an *athermanous* photometer, as being acted on only by luminous rays. Its principle is that a radiometer, whose temperature is constant, turns solely under the influence of light. The apparatus consists of a radiometer bulb fixed in the middle of a cube-shaped metallic case, having four lateral apertures, closed with glass, through two of which light can be sent horizontally, traversing the bulb, while the two others allow observation of the bulb. The case is filled with water, which, through four vertical tubes screened from the bulb, and surmounting spirit lamps, is heated to a temperature above that of the radiant heat of the sources to be measured—in practice about 100 deg. suffices. The bulb contains, *in vacuo*, a disc movable round a vertical axis; the half disc on one side of this axis being black on its two faces, the other white. When a single source of light acts on the bulb from one side, it attracts the white half and repels the black, so that the disc turns edgewise to the light, and presents one side to the observer. If another equal light act simultaneously on the other side and at the same distance as the first, the counter action results in the disc presenting its sides to the light, its edge to the observer. Where unequal lights are compared, one may always, by shifting one of them, bring the disc into the second position just specified, and by then measuring the distances, ascertain the ratio of the intensities.

SOCIETY OF TELEGRAPH ENGINEERS.—The Library of this Society was opened to members on the 10th November, 1880, and on the 1st January, 1881, was thrown open, with certain restrictions, to the public generally. From the Librarian's (Mr. A. J. Frost) Report to the Council, it appears that the number of visitors to the Library during the year 1881 was as follows:—Members 180, non-members 158, total 338. The Society possesses a collection of Specifications of Electrical Patents which is kept up to date. The extent of this collection may be guessed by the fact that 430 electrical patents have been taken out since January, 1881. More than 165 books and papers have been added to the library, and in addition, Mr. J. G. Symons, F.R.S., presented sixty works on lightning and lightning conductors. The Library is kept open in the evening until 8 o'clock on four evenings in the week.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

JANUARY 11.—"The Industrial Resources of Ireland." By G. PHILLIPS BEVAN.

JANUARY 18.—"The Relation of Botanical Science to Ornamental Art." By F. EDWARD HULME, F.L.S., F.S.A.

JANUARY 25.—"The Causes and Remedies of Bad Trade." By WALTER R. BROWNE, M.A.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

JANUARY 31.—"The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By WILLIAM COCHRAN.

APPLIED CHEMISTRY AND PHYSIC SECTION.

Thursday Evenings, at Eight o'clock:—

JANUARY 26.—"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By Dr. THUDICHUM.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

JANUARY 13.—"The Opium Trade." By Sir RUTHERFORD ALCOCK, K.C.B. Lord ABERDARE, P.R.G.S., will preside.

CANTOR LECTURES.

The next course of Cantor Lectures at the Society of Arts will be on "Recent Advances in Photography." By Captain W. de W. ABNEY, R.E., F.R.S.

LECTURE 1, JANUARY 30.—Introduction. Direct action of light. Action of light and development. Daguerrotype. Phenomena met with in photographic experiments.

LECTURE 2, FEBRUARY 6.—The effect of the spectrum on the different molecular forms of the silver haloids. Practical applications. Sensitisers considered. Sensitiveness of the different salts of silver. Sensitometers considered.

LECTURE 3, FEBRUARY 13.—Dry plate processes. Instantaneous pictures. Instantaneous shutters. Enlargements, direct and otherwise produced. Colour of developed prints. Applications of photography to science.

LECTURE 4, FEBRUARY 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 9....Society of Chemical Industry, Burlington-house, W., 7½ p.m. Mr. W. Weldon, "Some Recent Improvements in Industrial Chemical Processes."

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. Boyd Dawkins, "Commerce and Trade Routes of Prehistoric Europe." (Fraser Lecture.)

TUESDAY, JAN. 10....Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Inaugural Address of Sir W. G. Armstrong, on "National Defences."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Major-General Pitt-Rivers, President, "The Entrenchment of the Yorkshire Wolds, and Excavations in the Earthwork called Danes' Dyke at Flamboro'." With Diagrams and Illustrations. 2. Mr. J. R. Mortimer, "The Discovery of Ancient Dwellings on the Yorkshire Wolds."

Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. Annual Meeting.

WEDNESDAY, JAN. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. G. Phillips Bevan, "The Industrial Resources of Ireland."

Geological, Burlington-house, W., 8 p.m.

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, JAN. 12...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. H. Herkomer, "Familiar Arts."

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. W. J. C. Sharp, "The Invariants of a certain Orthogonal Transformation with special reference to their Use in the Theory of Strains and Stresses of an Elastic Solid." 2. Professor Wolstenholme, "Complete Determination of the Real foci and of the Equation of a given Ellipse, with respect to any Point." 3. Rev. N. M. N. Wilkinson, "Some Formulæ in Elliptic Functions." 4. J. Hammond, "On the Calculation of Symmetric Functions."

FRIDAY, JAN. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Sir Rutherford Alcock, "The Opium Trade."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.

New Shakspere, University College, W.C., 8 p.m. 1. Rev. J. Kirkman, "On Suicides in Shakspere."

SATURDAT, JAN. 14...Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, JANUARY 13, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

The Exhibition of Photographic Appliances, in connection with Captain Abney's Cantor Lectures on "Recent Advances in Photography," will be opened on the day of Captain Abney's first lecture, January 30th. The Exhibition will be kept open from January 30th, till about the end of February. Notice has been issued to all the intending exhibitors that their apparatus, &c., should be sent in on the 23rd inst. Members of the Society, and others, willing to send articles for exhibition, if they have not already communicated with the Secretary, are requested to do so at once, as nearly all the space available for the Exhibition has been applied for. Photographs, except as illustrations of special processes, apparatus, &c., cannot be received for exhibition. Arrangements have been made for showing the actual working of some of the more recent processes.

MUSICAL EXAMINATIONS.

The Society of Arts' practical Examination in Vocal and Instrumental Music was held, as announced, by John Hullah, LL.D., assisted by W. Barrett, Mus. Bac., on Monday, Tuesday, and Wednesday, January 9th, 10th, and 11th. 74 candidates were examined. Dr. Hullah's report will appear shortly.

The next practical Examination will be held in the second week in July, 1882. Information respecting these Examinations can be obtained from the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

SOME OF THE INDUSTRIAL USES OF THE CALCIUM COMPOUNDS.

By Thomas Bolas, F.C.S.

Lecture II.—Delivered November 28th, 1881.

Lime. The calcination of the carbonate in theory and practice. Influence of foreign bodies on the quality of the lime. Most favourable conditions for the decomposition of calcium carbonate. Cements and their uses. Lime as a refractory material. Lime-light. The oxy-hydrogen furnace. Lime moulds for the casting of iron and steel. Notes on a few of the industrial and economic uses of lime.

Just a few figures to commence with. The composition of the ordinary carbonate of lime, as represented by chalk, is expressed by the formula :—

$$Ca\,CO_3.$$

Ca stands for 40 parts of calcium by weight, C for 12 parts of carbon by weight, and O_3 for three times sixteen, or 48 parts of oxygen. Thus we have :—

Calcium	40
Carbon	12
Oxygen	48
	100

These figures, when added together, make just 100; so that chalk contains 40 per cent. of calcium.

When carbonate of lime is heated to redness under favourable circumstances, the whole of the carbon flies off in company with two-thirds of the oxygen ; the gaseous product thus constituted being called carbon dioxide. The whole of the calcium remains behind, united with one-third of the oxygen, this compound being ordinary lime. In symbolic language the decomposition is thus represented :—

$$Ca\,CO_3 = CaO + CO_2.$$

These symbols imply that 100 parts by weight of calcium carbonate split up into 56 parts of lime and 44 parts of carbon dioxide. Although the diminution of weight which a limestone undergoes when burned is 44 per cent. or more, as moisture and organic matters are often present, the reduction as regards volume is much less—say some 14 to 25 per cent.

Here is a small fragment of carbonate of lime in the form of marble. You see that the heat of this blow-pipe is directed on it for a few seconds only; but this suffices to effect the decomposition of a considerable proportion of the carbonate, so that, when it is placed on a sheet of damp and strongly coloured red litmus-paper, a vigorous blue colouration is immediately formed round the material. Although the carbonate of lime is so readily decomposed by heat under these circumstances, it is quite possible to expose it to an equally high temperature without decomposition occurring to a notable extent. If carbonate of lime is heated to redness in a closed iron tube, it simply fuses, and on cooling, it solidifies to a semi-crystalline mass, like marble. If it is heated under the ordinary atmospheric pressure, the decomposition is extremely slow, unless the carbon dioxide first liberated is removed by some means. This last fact is very well illustrated by an experiment which it will be easy to show you. Here is an iron tube which passes through one of Mr. Fletcher's new gas furnaces for heating tubes, and this tube is packed tolerably full of fragments of marble. In a few minutes the tube will be heated to bright redness, and you will notice that the evolution of carbon dioxide, as measured by the occasional bubbles which pass into the gas jar, is extremely slow. Notice now the effect of passing steam over the heated carbonate of lime. A rapid evolution of carbon dioxide takes place, and the receiving jar is almost immediately filled with the gas. A stream of air, or other gaseous matter, will produce a similar effect, but steam is most notably effective in expediting the decomposition of heated carbonate of lime into lime and carbon dioxide. In a similar way, the decomposition may be facilitated by a reduction of the pressure; as, for example, when the liberated carbon dioxide is continually removed by means of an air-pump.

A very high temperature is not by any means necessary for effecting the thorough decomposition of carbonate of lime; a moderate red heat being quite sufficient, if other conditions are favourable. A moderately rapid current of steam may be considered to reduce the time necessary for the decomposition to one-eighth, and a knowledge of this fact has led some to suppose that a notable advantage is gained by the burning of damp limestone. This supposition seems, however, to be unfounded, as one may readily believe when it is borne in mind that the greater part, if not the whole, of the water must be driven off long before the heat required for effecting the decomposition of the carbonate is reached. It appears, however, an advantage to place water-troughs in the air-ways of the furnaces in which lime is burnt. In connection with this point, it must not be forgotten that such fuels as wood and coal contain a notable portion of hydrogen, and when this burns, water is formed.

In some cases, as when the limestone is contaminated with a considerable proportion of clay, sand, oxide of iron, or alkaline bodies, it is desirable to take advantage of every circumstance which can facilitate the decomposition, as an elevated temperature would cause a partial vitrification of the lime, owing to its chemical union with the above-mentioned foreign bodies. Sometimes it happens that a sudden elevation of temperature will melt the surface only of the lumps of partially-burnt lime, and, as it were, glaze them over, and thus protect them from further decomposition, while in other cases the vitrification may occur all through the lumps. This vitrified lime will not slake at all, or will only slake imperfectly; but for all that it may, if finely ground, form an excellent hydraulic lime or cement; or, if mixed with a considerable proportion of a rich or "fat" lime, it may confer hydraulic properties on it. If the heat has been insufficient, so that the whole of the carbon dioxide has not been driven off, each lump of lime will include a kernel, containing a large proportion of the ortho-carbonate, $Ca_2 CO_4$. Such imperfectly burned lime will not slake on the addition of water, if it consists mainly of the ortho-carbonate; but if ground and mixed with water, it will slowly set, without having much tendency to crack.

These considerations will indicate the propriety of placing the small lumps of limestone, or the least pure varieties, towards the top of the furnace, or near the edges, while the large lumps of the purer stone may be placed where the heat is likely to be greatest. This remark only applies to a periodical furnace, which is burned out before being re-charged. The heat advisable in ordinary cases may range from 700° to 1,000° Centigrade, according to the quality of the stone.

Your attention will next be called to some diagrams of the various classes of lime furnace in use. The drawing which is now projected on the screen, represents one of the most primitive lime furnaces, but a form still in actual use. It consists merely of a dome-shaped heap, which is 15 or 18 feet across, and is built up of alternate laye s of fuel and limestone, and covered with loam, excepting the extreme top and an opening at the bottom, which leads into a tunnel-shaped channel, leading across the bottom of the heap. Although this primitive lime furnace is very wasteful as regard fuel, there are occasions when it is the most convenient arrangement for burning lime.

The next lantern slide represents a rudimentary shaft furnace, and, in most cases, such a furnace is excavated out of the limestone rock itself. It consists of a cylindrical shaft, about 14 feet in diameter and about one and a half times as deep, a small horizontal channel, serving to admit air; and a dome of limestone is generally built round about the place where the horizontal channel opens into the shaft, so as to allow an approximately equal distribution of the heat. This form of furnace works very satisfactorily, if carefully managed, and very many of them are in regular use all over the country. Those of you who travel on the South-Eastern Railway towards Woolwich, may see one by looking out of the right-hand window of the train, just after it has passed Westcombe-park Station. The next slides represent improvements on the simple shaft furnace, a fire-brick lining being introduced, the mouth being somewhat contracted; while methods of inserting sticks of wood, so as to lead the draught equally through the various parts of the mass, are shown. The diagram now before you shows another step in advance, a grate of fire-bars being introduced, and a permanent arch of firestone, or other refractory material, instead of the temporary arch built up out of the limestone itself. Many forms of interest must be passed over without consideration, in order that you may be enabled to study those furnaces which are continuous in their action, that is to say, are kept constantly burning, fuel and fresh limestone being added at the top, and the burned lime removed at the lower part, without extinguishing the fire. In the case of the furnace now represented on the screen, you will notice the damping arrangement for stopping the draught at the time of extracting the burned lime, the hot lime being raked into the cooling chambers, which are provided with ventilating shafts, in order to facilitate the operation.

It is probable that a notable future is before the process of burning lime by means of gaseous fuel, generated by such an apparatus as that of Siemens, especially when this method is carried out in conjunction with the principle of the ring-furnace, or annular kiln, next to be described.

The annular kiln will become intelligible to you by a study of the diagram which Mr. Barker will next project on the screen. In kilns of this description the fire-chamber may be regarded as a ring or closed circuit, placed in a horizontal position; but this ring need not be round, it being more usually formed like an oblong with rounded corners. The fire-channel or ring may be regarded as being built up of a number of segments, and a cut-off or damper may be inserted between any two of these segments. Each segment has a direct connection with the main chimney; which can, however, be cut off by means of a metal bell, which dips into a ring-shaped vessel containing sand; a form of joint which is extremely useful in furnace work. Each segment can also be opened so as to admit the external air or limestone; and fuel is added through small holes in the top of the ring-system.

Now, imagine that one of the dampers or diaphragms is inserted between two of the segments so as to block the ring at that point, and that the segment on one side of the damper, say the right-hand, is open to the air, while that at the other side is connected with the chimney. If the fire is now lighted at the open segment, the flame or heated air will have to circulate round the ring until it reaches the adjacent segment, or that on the other side of the damper, before it can reach the chimney. Things being allowed to go on, a period is arrived at when the maximum of combustion is seated at a point midway in the circuit, or opposite the damper. When this is the case, the segment where the fire first began is emptied of its lime, and fresh limestone put in; while at the same time, the damper is shifted, so as to add this segment to the unburned end of the series, the chimney being then connected with it, and the air-way of the next segment on the right is opened. By proceeding in this way, the point of maximum combustion can be kept nearly opposite the diaphragm, or damper, and that air which actuates the furnace becomes considerably heated in its passage over that lime which is already burned, while the waste gases impart a considerable proportion of their waste heat to that material which has not yet commenced to burn.

The waste of heat is so small in a well-constructed annular kiln, that in some cases as little as seven per cent. of fuel is used; and, moreover, the labour involved in working the furnace is not very considerable. Several thousand furnaces are in use at the present time, and whenever the operation of lime or cement burning is performed on a large scale, it is likely that this system will come into use, either with solid or with gaseous fuel. It is not at all necessary that the shaft or chimney should be built in the middle of the ring system, as represented in the diagram now on the screen; only when it is outside, some of the chimney channels must be a little longer.

If one wishes to increase the turn-out of a ring-furnace, it is merely necessary to use two dampers, and keep each half of the furnace in independent action, but in such a case the air passes over a less length of finished lime, and the products of combustion are less perfectly denuded of their surplus heat, by reason of the shorter length of unburned material over which they pass; there is, therefore, less economy of fuel than when one fire is kept burning in each furnace. If the ring, or annular channel, is made long enough, there is no reason why several fires should not be kept in circulation.

Well, now, lime is a compound of oxygen and calcium; but besides this normal oxide of calcium there is another oxide, which contains double the proportion of oxygen. This is, however, a very unstable body, which is of no particular interest out of the laboratory.

One of the most notable properties of lime is its extreme power of resisting the fusing action of fire, the intense heat of the electric are only serving slightly to soften it. This infusibility is taken advantage of in the lime furnace of Deville; this apparatus being used for melting platinum and other highly infusible metals. Here is a small one which will serve for melting half-an-ounce of platinum. The metal is placed in the hollow of the lower block, and the flame of a powerful oxy-hydrogen blow-pipe is made to enter at the top, as you now see. You notice how the incandescent lime glows, this glow being the well-known lime-light. Here is one of the usual arrangements for producing this light, A jet of coal-gas is crossed by a fine stream of oxygen, and the sharp and bluish flame is allowed to impinge on a small cylinder of quick-lime; this becoming incandescent almost immediately, and giving out the brilliant light which you now see. The lime-light is being used in this magic-lantern for projecting the photographic reductions of diagrams on the screen; and as the light in question is highly actinic, it is of frequent use in many photographic operations, and notably in making enlargements. It is very probable that, before long, the lime-light may compete with the electric light for the illumination of large buildings and open places.

Iron and steel may be satisfactorily cast in lime moulds. Here are some specimens which were poured into the moulds just at the commencement of the lecture, and if you will pass them round you can try them with this file. Certain continental engineering firms make considerable use of lime moulds for steel, and these moulds may either be cut out of blocks of lime, or they may be made like ordinary moulds, out of a mixture of tar varnish and powdered lime. In any case they should be heated to a low red heat before the metal is poured in.

The Gilchrist-Thomas process for the dephosphorisation of iron is well known to you; the converter being lined with lime bricks, which take up the phosphorus during the operation of "blowing." One of the bricks used is on the table, and you can examine it for yourselves. It is coated externally with pitch as a protection against the atmosphere.

When lime is brought into contact with water, combination soon ensues, and heat is evolved; a white powder containing $Ca\ H_2O_2$, and commonly known as slaked lime, being the result. The heat evolved by the slaking of lime has been known to cause fires, and one occasionally sees workmen cooking breakfast or dinner by the heat of a heap of slaking lime.

When lime is freely exposed to the air, it soon absorbs enough water to become slaked, but at the same time it absorbs carbonic anhydride, and is partially converted into ortho-carbonate, $Ca_2\ CO_4 + x\ H_2O$, a substance which is excellently well adapted for making mortar.

Lime dissolves in about 800 parts of cold water, but is somewhat less soluble in hot water, so that when this clear lime water is boiled, it will deposit a portion of its lime.

The principal use of lime is for making mortar, and in this case sand is used, not only to prevent the cracking which would happen if a mere paste of lime and water were used, but also to unite chemically with a portion of the lime, a layer of true silicate of lime being formed round each grain of sand. The conversion of the lime into carbonate takes place with extreme slowness, and appears to play a secondary part in relation to the hardening process, as samples of mortar taken from the great pyramid in Egypt were found to contain free lime.

The presence in lime of certain foreign

bodies, as clay, oxide of iron, silica, or manganese oxide, exercises a remarkable influence on the properties of mortar made with it, such mortar possessing, in a degree depending on many circumstances, the property of setting under water. Such a lime is ordinarily called hydraulic lime.

At Puzzuoli, in Italy, a remarkable volcanic product, called puzzolana, is found, this material consisting principally of silicates of calcium, aluminium, and sodium. When this puzzolana is intimately mixed with an ordinary or "fat" lime, hydraulic mortar or cement is obtained, which possesses most valuable qualities, and has satisfactorily resisted the destructive tendencies of two thousand years.

The mineral known as trass, and which not only is found abundantly on the banks of the Rhine, but also occurs in Ireland, is an analogous substance, and it is largely used in some parts of Germany and in Holland for making hydraulic mortar. Finely powdered silica, glass, or lightly-burned clay, in a state of minute division, possesses similar properties; but in the present day hydraulic cements are mostly obtained either by the careful calcination of impure limestones, as found in nature, or by the use of artificial mixtures—say of chalk and clay—made up to the required composition.

Enormous quantities of the so-called Portland cement are now manufactured in this and other countries, by mixing chalk with river mud; and, after the mass has dried, burning until incipient vitrification sets in. The mass, being now finely ground, forms an admirable hydraulic mortar, when mixed with water and sand. Before you are samples illustrating the manufacture of Portland cement, which have been supplied by Messrs. White Bros., and Messrs. Francis and Son. It is not necessary for me to enter into any detailed description of the Portland cement manufacture, as this would require a course of lectures by itself, and you can study it up for yourselves, by means of Mr. Reid's useful manual on this subject, and also his work on concrete.

The cement ordinarily called "Roman," is made from the nodules of highly ferruginous and very impure limestone, known as septaria, which are found in the Thames Valley, and it sets with great rapidity. Messrs. Francis and Son manufacture a similar article from the medina earth, which sets more rapidly than the ordinary Roman cement. They were kind enough to send me a small cask as a sample. A part of this was put to a practical test, by being used to mend a leak in the roof of my house, and the remainder is before you. Mr. Barker is now mixing some with water, and you will have an opportunity of seeing for yourselves how rapidly and firmly it sets.

Little can now be said as regards concrete, for the reasons already given, but a few illustrations of the admirable materials obtained by incorporating Portland cement, a hard material such as small stones, and water, are before you. The specimens lent by Mr. Lascelles, of Bunhill-row, illustrate his ingenious and quickly executed system of building with slabs, made of concrete, and the models on yonder side of the room show his method of mounting the slabs or blocks. A book of designs by Mr. Norman Shaw illustrates well the capabilities of Mr. Lascelles' system. One of these designs has been photographed as a lantern slide, and will be shown on the screen by Mr. Barker. It is surprising what a variety of things can be made of Portland cement concrete—even tables, chairs, and casks have been made successfully, but all subject to the drawback of being rather heavy.

Here are some fine examples of artistic casting in Portland cement, which have been executed by Messrs. C. H. and T. Mabey. Mr. Lascelles has also sent samples of finely moulded window dressings, and other decorative articles.

In connection with the subject of concrete, it is necessary to allude to the so-called patent Victoria stone, a material which seems likely to take a very high place among artificial stones. It consists in the main of a Portland cement concrete, the aggregate consisting of granite chips. When the material is set, it is soaked in a solution of sodium silicate, which harden it so much, that as regards strength and durability, it stands almost as high as granite itself.

Some artificial stones made according to Ransome's system are on the table. In this case sand, or pure silica, is cemented together by a strong solution of sodium silicate, and the articles are next hardened by a bath of calcium chloride, these stones are of especial value for making grindstones, sharpening blocks, and filtering slabs or vessels; uses which are illustrated by the samples on the side table. Messrs. Ransome and Co. also make use of the silicate of soda and chloride of calcium solutions for rendering soft brickwork or stonework impervious to damp; the liquids being applied alternately, and their value for this purpose is well illustrated by this brick, one half of which has been treated. Although there is scarcely any difference as regards the appearance of the two halves, you see that water is readily absorbed by the untreated half, but not by the portion which has been rendered impervious by the solutions of Messrs. Ransome and Co.

The dephosphorising properties of lime have been rendered available in obtaining compact masses of the refractory metal, iridium; the spongy metal being first fused with a moderate proportion of phosphorus, after which the comparatively fusible phosphide is heated in powdered lime, until all the phosphorus becomes removed.

As an indirect manure, lime possesses some value, decomposing silicates, disintegrating organic matter, and destroying insects. As an agent in various chemical industries, lime holds an important position; its uses in tanning, the preparation of the caustic alkalies, the liberation of ammonia, and other processes, being very considerable. With respect to its bearing on the iron industry, my remarks must be deferred until the utilisation of the furnace slag is considered. Some kinds of glass, as for example the hard Bohemian variety, contain a considerable proportion of lime; and powdered lime is often used in packing delicate articles of steel which it is undesirable to oil. In this case it most effectually prevents rusting.

JUVENILE LECTURES.

RECENT WONDERS OF ELECTRICITY.

By W. H. Preece, F.R.S.

Lecture II.—Delivered on Wednesday, 4th January, 1882.

Last week, when we had the pleasure of meeting, I endeavoured to disabuse your minds of any such idea as that electricity was a fluid, or, in fact, any kind of matter. I pointed out to you that every electric phenomenon really was a form of that curious, mysterious agency that exists throughout nature, that produces all the work done on the face of the earth, that probably is at the root of life itself, called energy. Nevertheless, we can speak of electricity as though it were a distinct entity; precisely in the same way that we speak of sound, of light, and of heat. We know that sound and heat are not sensible to the touch, or taste, or sight; so electricity is of the same character, and is invisible and insensible in every shape or form. Morover, we cannot either create or produce energy; there is only a certain fixed quantity of energy in the universe, and all that we can do is simply to transform it into its different shapes, such as I illustrated to you last week. All physical phenomena, without a single exception, may be traced to the mere transformation of this energy. I showed you on the last occasion how, by simply winding a wire round a mass of iron, and sending a current of electricity through the wire, we could produce that form of energy called electro-magnetism. To-night I have to speak of one or two other forms in which this energy does its work, forms in which, when electricity is transferred through matter, it does work in some shape or another. The operation of the electric current, when passed through chemical compounds in solution or liquid, is to tear asunder the constituents of the compound, and to arrange them on different sides. A simple means of illustrating this is a glass jar, like the one before you, containing water and two glass tubes, each fitted with a stop cock. When an electric current is passed through the water, the elements of water, oxygen, and hydrogen, are driven asunder, and take refuge, as it were, in the right or left-hand tube respectively. To prove that these gases have been collected, if a lighted match be placed over the hydrogen tap, the hydrogen will give evidence of its presence by inflammability; but if the match be blown out and immediately presented to the tap of the tube containing the oxygen, that gas will make its presence evident by relighting the match. [Experiment shown.] The effect of the passage of electricity through water is something like the effect which would be produced by a storm, or other agency, in this room, which caused all the boys of this audience to go to one side, and all the girls to go to the other—excepting that in water there are always two parts of hydrogen to one part or volume of oxygen. Not only does the current tear asunder the oxygen and hydrogen of water, but it also breaks up the constituents of most of the chemical compounds, and the weight of material decomposed per second is an exact measure of the work done, and of the current flowing. For instance, if we take a solution of sulphate of copper and pass electricity through it, the solution is broken up into copper and sulphuric acid, and if a bunch of keys were put into the solution while the electricity was passing through it, the keys would receive a deposit of copper. If nitrate of silver solution were used instead of the sulphate of copper solution, silver would be deposited upon the keys or piece of metal inserted. Through the kindness of Mr. Bolas, I am able to show you an experiment of this kind, which will enable me to give you a record of this evening's entertainment. I have here, a large glass dish containing a liquid, which, no doubt appears to you like water, but, which is really a solution of the double salt of cyanide of silver and potassium. In this solution, I now place a piece of sheet copper, which you see has the usual appearance of copper all over it. Now, while that plate of copper is inserted to one half its extent in water, we will pass electric currents through the liquid from the hand-dynamo machine on the table [experiment proceeding], which cause the cyanide of silver to break up into cyanogen on one side, and silver on the other, and if I take out the plate of copper, you see there has been deposited upon its immersed surface a coating of silver. Silver spoons and all the various kinds of electro-plate wares receive their silver deposit in the manner I have just shown you. Now, we will set this small dynamo-machine in action by turning its handle, thus converting the energy of the human body into electric energy; and we will immerse a quantity of brass buttons in the liquid, which, when they have received their coating of silver, will be laid aside, ready for distribution as a memento at the close of the lecture. Through the kindness of Messrs. Elkington, I am able to show you the handsome specimens of electro-plating which hang on the walls of the room, and which were plated at their works at Birmingham, by a process exactly similar in character to that I have described, excepting that steam-power is substituted for the manual labour you just saw for producing the electric currents.

We next come to the work performed by electricity in passing through solids. The result of that work is simply the production of heat. Before me you will notice two brass stands, and between them I will suspend a piece of fine platinum wire. I now join up one of my battery wires (the same that I used last week) to one of the brass stands, and touch the other brass stand with the other battery wire; the effect appears as a red glow in the platinum wire. If I bring one of my battery wires from the bottom of the brass stand to the end of the platinum wire, the colour of the glow becomes brighter; and as I move my battery wire along the platinum wire the glow or light produced by the high temperature in the platinum becomes more and more intense, until finally, when it reaches a certain temperature (about 3,000° Fahr.) the wire is ruptured, and falls to the ground. That is evidence that the passage of electricity, through solid conductors, produces heat, and the amount of heat produced is proportioned to the work done in the battery. Energy expended in one part of a circuit must be given out at another. If zinc is consumed in a battery, it generates a certain amount of energy, that energy must be evident in some other part of the circuit, and the heat you saw in the platinum was really the heat that would have appeared in the battery itself if we had not caused the current to flow through a solid conductor which offered a considerable amount of resistance to its progress, as compared with the resistance in the battery itself. This power of producing heat has been utilised in various ways, such as for firing fuses. [An Abel fuse was exploded.] At many places throughout the country, time guns are fired by such an electric fuse to announce the Greenwich time current at a certain hour. Mines and torpedoes are exploded in a similar manner; quarries are blasted, and many other results are brought about by passing electricity through platinum wire placed in explosive substances, or by special fuses. I do not intend to frighten or alarm you, but for your amusement, and through the kindness of Professor Abel, I have had fuses fixed out of harm's way at various points round the room, and when a small current is passed through them you will hear the explosion produced. [Experiment carried out.] Those fuses might have been fixed miles away, and the same effect would have been produced, and from it you will understand how a number of charges can be fired, or a number of guns can be discharged simultaneously on board our large men-of-war.

The next branch of the subject is the work done by electricity in its passage through air and gases. I have shown you that, in its passage through liquids, it tears the constituents of the solution asunder; in its passage through solids heat is produced; and in its passage through air, it not only produces heat, but violent projection of material particles as well, which it renders incandescent, producing sparks, heat, and other disruptive effects. To illustrate this, I have provided an Apps' induction coil, to which can be joined up vacuum tubes of various kinds, and through which the currents produced by the hand dynamo-machine will be passed. [A beautiful collection of vacuum tubes, fitted with various rarefied gases, was then shown, while the lights were turned down.] In those effects we have the result of electricity passing through air, and gases of extreme tenuity, and also an indication of the way in which electricity produces heat—and, therefore, light—in gaseous matter. All instances of artificial lighting or heating are simply due to the fact that we are able to produce heat, and heat of a very high temperature. It is a curious fact that all matter, whether metal or porcelain, carbon or lime, begins to emit light at precisely the same temperature, which closely approaches 1,000° Fahr., or, to be accurate, I believe it is 980° Fahr., so that, whenever it is possible by any means to raise any material to that temperature, light is emitted, and the intensity of light increases, until, in the case of carbon, when about 4,000° Fahr. is reached, the material is destroyed. In platinum a lower figure (3,082°) represent the point of fusion. To obtain this very high temperature by electric currents, we must utilise higher means of producing the electricity than I have hitherto shown you. In the battery I have just used, the electric current was produced by the combustion of zinc, but now I want to explain to you how, as I said, muscular power was converted into electric energy. The reason is simply due to the fact discovered by Faraday, that whenever a wire or conductor moved through the sphere or field of a magnet it became electrified. I take up the brass rod before me and move it rapidly, and by doing so have to a certain extent electrified it by causing it to pass through the magnetic field of the earth. The earth is an enormous magnet, a fact which we know, because our compasses guide the mariners across the deep. The air in this room is under the influence of the earth's magnetism, and if I move a wire or rod within that influence, at right angles to the lines of magnetic force, I cause it to be electrified, but only to an excessively small extent. The strength of the current produced, depends upon the strength of the magnetic field, and upon the velocity with which the conductor moves across the field. Instead of having only one rod, or one wire, we have in this hand machine, an arrangement of a thousand turns of wire, instead of having the weak magnetism of the earth, we have the powerful field of permanent magnet, and instead of causing it to move through the air by the velocity of my arm, we apply multiplying gear, which, as you see, imparts velocity to it of great rapidity. Thus motion, through a magnetic field, produces an electromotive force. There never can be a continuous electromotive force without some source of energy. Here we have mechanical energy expended, and all the conditions for the production and maintenance of a current. Energy expended in one point must be found in some form in another point. If it is not utilised, it is wasted. Some of it must always be wasted, and the true economist will try and waste the least possible quantity. If I place a piece of platinum wire between the two wires connected with the hand dynamo-machine, you see that the muscular energy of my assistant, by turning the handle, generates currents of electricity, which give a red heat to the platinum wire. The energy of the body is thrown into the machine, the machine converts it into electricity, the electricity passes through the wire, which, by having work done upon it is rendered incandescent, and, in consequence, becomes luminous. I have here a lamp containing a piece of platinum wire, and if I connect it to the wires of the dynamo-machine [this was done], the platinum glows and gives us light. It is a machine precisely similar in principle to the one now before you, fixed under the arches on the Thames-embankment, and worked by a steam-engine (lent for the purpose by Messrs. Robey), that is supplying currents of electricity to the lamps now lighting this room. There is an occasional throb in the light; this is produced by the unsteadiness of the engine, which was not specially prepared for the purpose, but was the best available. It is, in fact, an agricultural machine. There are two kinds of electric machines of this class. One is called the magneto-machine, like the one before you, because the magnetic field is produced by the presence of a powerful permanent magnet, which I think is visible to most of you, and which consists of several pieces of steel that have been magnetised. The other kind of machine is called the dynamo-machine, in which the magnetic field is produced by an electro-magnet, which is itself excited by the currents it generates, so that there is a kind of accumulative action, one current piles up the agony on the other current, and all of them together, acting on the electro-magnet, increase the total effects until the iron is saturated with magnetism. So much as regards the production of currents for electric lighting purposes. The motion of the conductor through the magnetic field may be caused by the energy of coal, which is consumed to generate heat and steam for working a steam-engine; or, as at Godalming, by the energy of water on a water-wheel; and it is very probable that where water is available, it will be the most economical source of energy for electric lighting purposes. Sir William Armstrong, at his seat at Craigside, near Newcastle-on-Tyne, has illuminated his house for some time by currents of electricity, produced by a waterfall in his grounds, so that, he says, his library and his drawing-room are lit by the river flowing through his grounds. As regards the light itself, there are two kinds of lamps. I have already explained and illustrated to you the fact, that electricity in its passage through air produces sparks. I have here what is called an arc lamp; in it two rods of carbon are held by two brass clips (not in metallic connection with each other), and the ends of the carbon are, when in action, a short distance apart. On joining up the wires to the brass clips the current flows, a bright light is instantly set up in the air between the carbon points, and the arc is formed. This light is due to the passage of an infinitely rapid succession of particles of carbon which are projected across the air space, which, in their high state of incandescence, produce light, and which in brilliancy would not compare unfavourably with that of the sun. The light from a larger arc lamp would be far more brilliant than this, but I do not want to damage your eyes or my own. I have experimented on the electric light so much, that I have suffered great tortures from the irritating and exciting influence of its bright rays upon the retina of the eyes, and I advise all people who have an opportunity of examining the arc light, not to look at it too much, or the eyesight may be unfavourably affected. The arc light is used principally for lighting large areas, for instance, Charing-cross Station is lit by one form of arc light, called the Brush; Cannon-street Station is lit by what is known as the Brockie lamp; the space in front of the Royal Exchange is lit up by the Siemens arc lamp; King's-cross Station is lit up by the Crompton plan; and so on. A very brilliant arc lamp at Paris, which attracted a great deal of attention, was called the Jasper light. But all arc lamps play upon one string, similar to the plan I have just shown, viz., that when two pieces of carbon are maintained at a certain distance from each other, and electricity passed between them, great heat and brilliant light is the result. There are certain difficulties in arc lamps which militate against their employment for domestic and internal use generally. The light is very intense; the effect is irritating; the ladies do not like it (and they are a powerful influence in this country), because it does not suit their complexion, nor their style of costume for evening wear: they have set their faces against it for internal illumination, and that being so, it is all up with it. Now, the light that is going to supplant the arc light for domestic purposes, is the incandescent light. The principle of the incandescent lamp is exactly the same as that I showed you in Mr. Becker's lamp, viz., that a suitable substance is enclosed in a glass bulb, from which the air has been extracted, and is brought to a high state of temperature by the passage through it of currents of electricity. The lamps illuminating this room are Mr. Edison's incandescent lamps, whose representative, Mr. Johnson, has been most indefatigable in his assistance for these lectures. The Edison lamp consists of a single curl, or loop, of a fine carbon filament (instead of platinum wire) placed in an exhausted glass bulb. The carbon is extremely thin—as thin as a human hair—but, in spite of its extreme tenuity, you see [knocking a lamp on the table] that concussion or shaking does not cause it to break, but it possesses great resilience, and vibrates like a steel spring; and it is so refractory that it will stand electric currents of enormous strength. As I have said, the lamps before you are worked by electric currents generated by an Edison dynamo-machine on the Thames-embankment, but each lamp is self-regulating and (you see) can be turned on and off by turning a tap very like those used on gas-brackets. The stronger the current supplied to the lamp, the greater its heat and brilliancy, and when, by turning a handle in the instrument I have for the purpose, the strength of the current is increased, it forms a brilliant light in the glass tube, until the amount of current is greater than the carbon can stand, when it radiates a beautiful blue haze, which iudicates that its end is near, and then it is broken (as you see), and the lamp goes out. I can easily replace the broken lamp by unscrewing it out of its socket, and placing a fresh one in its place, when at once all is in good order, and the light resumed. These lamps are water-tight as well as air-tight, and to prove this, I will insert a lighted lamp into the little aquarium on the table, when you see that the globe is brilliantly lit up, and that the fish it contains show rather a sign of curiosity than discomfiture, and seem rather proud of their colours which are so distinctly brought out by the brilliancy of the light. Here I have a globe of coloured water to show what brilliant effects can be produced. A good deal has been said about the dangers of electric lighting, and how careful we ought to be in its use, and there is no doubt that electricity is a very dangerous agent if you do not know how to use it. We have heard of the danger from fire through its use in theatres and houses, but I want to show you that, when I place a cambric pocket-handkerchief round a lamp, which I then break while electricity is going through it, no spark or fire of any kind occurs, but the lamp instantly goes out. [Experiment shown.] There is also danger from wires coming in contact with each other, and in that case they short circuit the machine; they cause an increased strength of current to flow, producing heat, and in that manner setting fire to houses. To obviate this danger "safety-catches" have been introduced by Mr. Edison. These safetycatches consist in the insertion of a very small piece of lead wire in the circuit, which is readily fusible, so that if the current becomes unnecessarily powerful, it passes through the lead wire, heats it to fusing point, and so breaks down the section on which the "safety-catch" is placed, eliminating at once all danger. [Illustrated.] It does not affect any other lamps, as you see. When the fused safety-catch is replaced by a good one, the lamps which were broken down by its rupture become lighted up again. We have the means of regulating the lights now burning in the room. Here is an apparatus in connexion with the machine at the engine-station, and by moving the handle and inserting in the circuit a certain amount of resistance, I am able so to reduce the current flowing from the machine that a considerable lowering of the light takes place. On turning the handle back again, the former brilliancy returns. That shows the electric light in the latest stage of its perfection. We have a bright light now in this room, but no impure gases are given off by the electric light and the air is not vitiated by it. The room is warm, but that warmth is due to the number of people present, and not to the heat produced by the electric light; though the electric light does, as I have said, generate heat to produce its effulgence. Many people talk of the electric light as being "cold" and cheerless. The light produced by the arc lamp does look cold and cheerless; but the soft, delicious, incandescent lamp before you has just as soothing an effect upon the eye as the prettiest lamps, or the pleasantest candle; and it has certainly removed all the objections that were previously raised to the electric light for internal illuminating purposes.

The next and last branch of my subject is the transmission of motive power to a distance. I have shown you how currents of electricity are produced; also how they do work; how they produce electro-magnetism; how they generate heat; how they produce light; and now I want to show you that the whole thing is reversible. If, by the exertion of mechanical power, currents of electricity can be produced, those very same currrents of electricity can in their turn produce mechanical power. If instead of receiving currents of electricity from the dynamo-machine on the Thames-embankment, we transmitted currents of electricity to it, we should cause it to rotate, but in the reverse direction. I have here a small machine for the purpose of illustrating this to you, it is the invention of Mr. Griscom, who has supplied it to a large extent in America for turning sewing-machines. The wires from the hand dynamo-machine are now attached to the Griscom motor, and when currents of electricity are generated by turning the handle of the dynamo, they are conveyed to the motor, and cause it to revolve with the high rapidity you see. It is surprising that such a tremendous momentum should be produced by so small a strength of electric current. The wires connecting the two machines in this instance are short, but the effect would have been practically the same had the machines been miles apart. By changing the wires, the direction in which the motor rotates is reversed, so that I not only get power transmitted, but can reverse its direction. In this case, as the electricity is generated by hand, its power is small; and, therefore, with my strength (which is only about one-twelfth of a horse-power), I can stop the rotation of the motor; but if steam-power were employed to generate the electricity, the power transmitted would be beyond my control, in that sense. This motive-power was illustrated, in many different forms, at the Paris Exhibition; for instance, from the commencement of the Champs Elyseés to the Exhibition building, a tram-car was propelled (sometimes at the rate of 25 miles an hour) upon rails laid down for the purpose, and during the time that the Exhibition was open, that car carried 75,000 to 80,000 people, who were conveyed to or from the building by motive power, generated by steam in the Exhibition, and conveyed by wires to the farther extremity of the track. An electric railway will form part of the

Electric Exhibition at the Crystal Palace, and among the proposals to be laid before Parliament next Session is a project for constructing an electric railway between Northumberland-avenue and Waterloo Station. Again, at the Paris Exhibition, an enterprising firm of agriculturists showed land-ploughing by electricity, and in fact, the application of electricity to innumerable useful purposes was illustrated; rock boring, newspaper printing, driving of sewing-machines, embroidery, leather work, glass-cutting, wood-carving, lifts raised, ventilation assisted, &c. I am looking forward to the Crystal Palace Exhibition with great interest, to see how far these exhibits will be repeated. The Exhibition will be well worth a visit; in fact, all Exhibitions are worth visiting, for they excite interest, they induce everyone, more or less, by generating curiosity, to add to his knowledge, they honestly stimulate national as well as individual competition, and they always result in the enlargement of the useful application of a power like that of electricity, because a man of one trade who sees electricity used in another trade cannot resist thinking out whether it cannot also be usefully applied to his own purposes. We sometimes hear electricity spoken of as a mysterious agency, and sometimes as a wild, untamed beast. It is only mysterious to the ignorant, and it is only untamed to the unskilled. I hope that the promise I made to you at first starting, that you would leave this room with a fair knowledge of how the electric light is produced, has been fulfilled, and I can only add that electricity will always prove an obedient slave to those who take the trouble to understand it; but it may, and it has, proved a very dangerous ally to the ignorant and the unskilled.

A hearty vote of thanks was accorded to Mr. Preece for his two lectures.

SIXTH ORDINARY MEETING.

Wednesday, January 11th, 1882; ANDREW CASSELS, Member of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Ainslie, Oliver Alexander, F.R.Hist.Soc., 48, Lincoln's-inn-fields, W.C.
Birkbeck, Edward, M.P., Horstead-hall, Norwich.
Brereton, Cuthbert Arthur, M.I.C.E., 23, Delahay-street, S.W.
Brind, Alfred Walter, M.I.C.E., East Preston, near Worthing.
Burch, Nathaniel Geach, Brunswick-house, Dartmouth-park, Forest-hill, S.E.
Carmichael, David, Ward Foundry, Dundee.
Carter, E. Harold, F.S.S., 33, Waterloo-street, Birmingham.
Cook, Arthur Stanton, 14, Furnival's-inn, E.C.
Cooke, William Henry, Lea Bank, Coppice, Oldham.
Common, Andrew Ainslie, F.R.A.S., 63, Eaton-rise, Ealing, W.
Cropper, Samuel, 28, Budge-row, Cannon-street, E.C.
Crossley, Richard, Bentcliffe-house, Accrington.
Cust, Robert Needham, F.R.G.S., 64, St. George's-square, S.W.
Dadson, Albert William, 6, Raymond-buildings, Gray's-inn, W.C.
Dowson, Joseph Emerson, A.M.I.C.E., M.I.M.E., 3, Great Queen-street, Westminster, S.W.
Fell, John, Augusta-place, Leamington.
Fyfe, John, 9, Grosvenor-terrace, Glasgow, and Young's Parraffin Light and Mineral Oil Company, 7, West George-street, Glasgow.
Henderson, Ridley, 9, Bush-lane, Cannon-street, E.C.
Holthouse, Carsten, 15, Percy-st., Bedford-sq., W.C.
Jones, Thomas John, 12, Princes-street, Hanover-square, W.
Kingzett, Charles T., F.C.S., F.I.C., 17, Lansdowne-road, Tottenham.
Ladd, John Haskins, 116, Queen Victoria-street, E.C.
Leonard, Hugh, 7, Hanover-square, W.
Lloyd, Robert Samuel, 84, Upper Whitecross-st., E.C.
Macdonald, Colonel R. M., 80, Oxford-gardens, North Kensington, W.
Moll, Frederick Henry Ludwig Raphael, 18, Old Broad-street, E.C.
Radford, Frances, 26, Pembridge-gardens, W.
Russell, Joseph, Glenclune, Port Glasgow.
Schram, Otto, 49, Wood-street, Woolwich, S.E.
Scott, Edward Lionel, Salters'-hall, St. Swithin's-lane, E.C.
Simpson, James Carrington, M.I.C.E., Broadway-chambers, Westminster, S.W.
Speck, Thomas Samuel, M.I.C.E., 8, Eaton-rise, Ealing, W.
Wallis, George Ambrose, M.I.C.E., 14, Sea-side-road, Eastbourne.
Watson, John William Mitton, M.I.C.E., Clevemont, Silverhill, St. Leonards-on-Sea.
Williamson, George Charles, The Institute, Guildford.

The following Candidates were balloted for and duly elected Members of the Society:—

Allfrey, Edward Richard, South Eden-park, Beckenham, Kent.
Austin, Josiah, Nechells-house, Nechells, Birmingham.
Ayrton, William, Wigan-road, Ormskirk.
Clerk, John Somervail, 39, Prince's-square, W.
Colvin, Clement S., India-office, S.W.
Glover, Walter T., Moorhurst, Kersal, Manchester.
Hallett, Holt Samuel, M.I.C.E., F.R.G.S., 37, Edgware-road, W.
Hawksley, Thomas, 97, Adelaide-road, N.W.
Hill, James Woodward, A.M.I.C.E. (Mayor of Bedford), Kimbolton-road, Bedford.

Knox, B. D., Caversham, Reading.
Peck, Robert, Lowlands, Half-moon-lane, Herne-hill, S.E.
Stuart, Robert Henry Frederick, A.M.I.C.E., Holmwood, Kew, Surrey.

The Paper read was—

THE INDUSTRIAL RESOURCES OF IRELAND.

By G. Phillips Bevan, F.G.S., F.S.S.

The materials of the paper which I have the honour to read before you this evening, have already formed the subject of one read before the Statistical Society very recently, and I should hesitate to reproduce the same within so short an interval of time, had the questions treated of been of less importance than they are. The problem, however, of what is to be done with Ireland in the way of permanent improvement, is one of such pressing necessity, that I trust that I may be excused for urging it with some persistency upon the public attention.

The first and greatest proof that the industrial circumstances of Ireland have not been improving of late years is seen in the statistics of the population, not only in the general decline, which according to the Census of 1871 showed a decrease of three-quarters of a million, and in 1881, of a still further quarter of a million (in round numbers), but also in the decline of that particular section of the people which is engaged in industrial pursuits. I do not intend this evening to put before you any alarming rows of figures, and shall content myself with the simple facts of which these figures are the index. As the industrial tables of the census of 1881 are not yet available, we must fall back on those of the previous decade, which show that the agricultural class had somewhat increased, while the industrial class, never a very large proportion in the Irish population, had decreased by 129,137; and again, the non-productive class had increased from 850,353 in 1861, to 2,813,563 in 1871. A portion of this startling number must be credited to wives and children of tender age; and it is also to be hoped, and may be reasonably supposed, that some difference of classification between the two Census periods may account for a good many; but, after taking into consideration these qualifying facts, there seems only too good grounds for presuming that the non-productive class has terribly increased, and the very vagueness of the term gives strength to the presumption. As regards the question of sex, we find a decline of females very marked in the industrial section, a fact which bears strongly on textile occupations generally, while, as regards age, it is still more unsatisfactory to note the very small number of industrially employed children, viz., those under 15. It appears that out of a total population at that age, of 1,915,276 in 1871, only 27,253 were industrially employed, of whom 21,562 were in the textiles. In the agricultural class, there were 53,385 employed under 15, making a total of children at work 80,638. Up to the age of nine years there were 1,165,602 children, and, therefore, we may dismiss them as being industrially useless; but after deducting these, plus the 80,638 who *are* employed, there is still a residue of 669,036 who are apparently contributing nothing to the labour of the country. Surely some light and remunerative industry might have been found for a good many of these. Turning to the groups of occupations with which the Census tables furnish us, we find that there were 47 in the industrial section, of which 31 showed a decline in the number of workers. The chief of these were—cotton and flax, dress, wool and worsted, building, wood, animal food, iron and steel, and vegetable food; while an increase appeared in trades dealing with mixed materials, drink, machinery and tools, stone and clay. The decrease of actual workers in the first-named list, was 144,191, while the increase in the others was only 15,743. The decrease in building trades is natural, and easy to understand, considering that for a long time past Ireland has offered some remarkable disadvantages as a place of residence for the higher classes, while, with a languishing industrial condition, there is but little demand for houses for operatives. The most serious decrease was in the textiles, viz., cotton and flax, 69,830; dress, 36,198; wool and worsted, 20,700. Approaching the textile statistics from another point of view, viz., the factory returns, we find that in 1871, there were 244 factories, employing 61,884, while in 1878 (the next return made) there were only 241, employing 61,630 hands. This certainly seems to corroborate the main fact, that there has been a decided retrograde movement in industrial matters; and though the next Census returns may throw a more hopeful light upon the gloom, we cannot, under the circumstances, be very sanguine.

Let us now, however, pass on to the actual industries; my object being to show what has been done in times past, and what one may reasonably hope may be done, with the materials which we know to be present. My statements will be taken from various authorities who have at different times examined the internal resources of Ireland; and even though these reports have to be somewhat qualified, we ought to listen to them until they are disproved. I say this, because nobody who has paid attention to these matters can help noticing that there is in certain quarters an apparent determination to ignore or pooh-pooh the industrial aspect of the country altogether, and that even many Irishmen are curiously apathetic on what should be a matter of the most vital importance. Ireland is, unfortunately, not rich in coal or iron; but it would be equally far from the truth to say, as many people do, that she is so deficient in them as to be practically without them. The fact is that there are both, in fair quantities and tolerable quality, and there seems to be no reason why they should not be utilised a great deal more than they are.

Coal exists, more or less, in fifteen counties; while iron ore is found in eight. Geologically speaking, the coal basins are seven in number, though they are generally grouped into the four fields of Leinster, Munster, Connaught, and Ulster. The character of the two most northerly basins is entirely different from the others—the former being free-burning or bituminous, the latter anthracite or stone-coal. The Leinster coal-field extends over portions of Queen's County, Carlow, Kilkenny, and Tipperary, and contains, as shown in sections at Castle Comer, some seven beds of coal, having an aggregate thickness of 18 feet 4 inches. Professor Hull estimates (1880) that the Leinster field contains, in the three first counties, an unworked tonnage of 86,202,000, with an available tonnage of 77,580,000; while the Tipperary prolongation has 29,500,000 tons unworked, and 25 millions available. The Munster field, stretching into the counties of Clare, Limerick, Cork, and Kerry, is extensive in area, but the seams are thin and few in number, and therefore only of local importance, though coal is pretty largely worked between the rivers Blackwater and Kanturk. The beds at Duhallow (county Cork) are stated by Sir Robert Kane to be of excellent anthracite, there being six beds, of which half are valuable, and known as the bulk, rock, and sweet veins. According to Hull, this field is estimated at 23 million tons, with 20 millions available for use. The Connaught (sometimes called the Arigna) field is the least known, and the most neglected of all. It extends into counties Fermanagh, Leitrim, Roscommon, and Sligo, and contains three beds of good bituminous coal, respectively 9 inches, 2 feet 6 inches, and 3 feet in thickness. The estimated unworked coal is 12 million tons, and the amount available 10,800,000. The Ulster group possesses three different basins, that of Tyrone, Antrim or Ballycastle, and Monaghan (the latter insignificant). The Tyrone basin, which is bituminous, ought to be, according to Professor Hull, the great storehouse of coal for the north of Ireland, but it is so unsystematically worked that it contains only eight collieries; while the whole produce of the Ulster field in 1877 was only 15,380 tons. Nevertheless, the estimated quantity is 36,950,000 tons, with 32,900,000 available. There are seven workable beds in the Tyrone basin, having a thickness of 30 feet, and placed, as it is, within easy reach of the manufacturing districts, ought to be of very considerable importance and value. The Antrim basin is at Ballycastle, and contains three beds of coal, respectively 3 feet, 3 feet, and 4 feet thick, while at Murlough Bay there are four beds. The late Sir Richard Griffith said of the Tyrone basin, that amongst all the sections of the English coal-fields, there is scarcely any example of the same thickness of coal within the same short distance from the surface. The fluctuating and feeble character of Irish mining is evident from the fact that, although there is an available quantity of 182,280,000 tons, the annual output within the last nine years has never exceeded 140,000 tons, and in 1880 (the date of the last mining statistics), was only 133,719 tons; while the number of collieries varies from 33 to 53, averaging a yearly yielding of from 2,271 to 3,592 tons. and yet, in 1846, according to Kane, the Leinster and Tipperary fields alone yielded, the one, 120,000 tons, the other, 50,000, while the Connaught basin produced 3,000, making 153,000 tons, without taking into account the Munster and Ulster fields. Most of this coal was sold at from 11s. 6d. to 12s. per ton. Mr. Dickinson, in whose district, as H.M. Inspector, the Irish collieries lie, states in one of his reports (1877) that the amount of coal got per person is 113 tons during the year, which is only a little more than one-third of the get in Lancashire, where the average is 301 tons per head. Of course, the Lancashire collieries are larger, the seams thicker, and the condition of the pits more favourable to work; but even taking these things into consideration, the disproportion is sadly great. As regards the quality of the coals, we have Sir Robert Kane's authority for the statement, after analysing the various beds, that the majority of them are excellent, and applicable to every kind of industry. His opinion must be rather cautiously received on this point, as there is no doubt but that some of the coals, such as the Leitrim, are by no means of first-class character, though the Leinster and Leitrim coal, in their various uses (it being borne in mind that the one is bituminous and the other anthracite) are fairly good, and the real difficulty as to the use of Irish coal, and the undisguised preference for Welsh or Scotch coal, appears to me to lie rather in the expense arising from careless working, indifferent machinery, and exorbitant royalties. It is quite clear that there is room for much improvement in Irish coal mining; and were these difficulties removed, the cost of railway transport lessened, and the facilities of communication increased, I am confident that a considerable proportion of the quantity of coal annually imported into Ireland (namely, 3,000,000 tons) would be supplied from the home collieries. Belfast alone took 882,182 tons in 1880, a large amount of which might just as well have come from the Dungannon coal-field as from Scotland.

The next point that demands our attention is that of iron ore, which is so frequently, though not necessarily, associated with the industry of coal mining. Ireland is certainly less rich, comparatively speaking, in iron, than in other ores, but there is no foundation for the oft-repeated assertion that she has no iron, and therefore cannot have an iron trade. The raising of iron ore is confined to five counties, viz., Antrim, Derry, Down, Donegal, and Wicklow, although nine-tenths of the quantity is obtained from the first-named, which is exceedingly productive. The Antrim mines are most prolific in aluminous and pisolitic iron ore, which therefore forms the bulk of the ore raised throughout Ireland, the remainder consisting of brown hæmatite.

There are about 24 iron mines opened throughout Ireland, though, like the collieries, they fluctuate somewhat; but it is satisfactory to note that the yield for 1880 (which was 239,325 tons) is a decided increase on former years, showing either greater activity in the iron trade, or an improved method of working. But the ore-producing localities here represented do not by any means represent the total of Ireland. Dr. Boate, an industrial writer on Ireland two and a half centuries ago, tells us that there were "iron mines in Munster, near the town of Tallow, by the Earl of Cork's ironworks, and also in Leinster, in King's County, in a place called Desart land, belonging to one Sergeant-Major Pigott, which rock is of so great a compass, that before this rebellion, it furnished divers great iron works; also in Ulster, in the county of Fermanagh; upon Lough Erne, in the county of Cavan, at a place called Doubally, in a dry mountain; in the county of Tyrone, not far from Lough Neagh; in King's County, two miles from Montrath; in Connaught, in Tomound; in the county of Clare, six miles from Limerick; in the county of Roscommon, by the side of Lough Allen; and in the county of Leitrim, on the east side of the said lough." Now, for this goodly list of iron-producing places to have been known to a writer two hundred and fifty years ago, when information was difficult to obtain, and knowledge on these subjects very scanty, shows that the iron trade in Ireland was in those days a recognised fact; and we know from other sources that the country was sprinkled with ironworks; charcoal-burning, it is true, and not on a very large scale perhaps, but remarkable for producing the finest quality, equal to that imported from Sweden, and sufficient to justify its being considered as a national industry. To come down to more recent times, Sir Robert Kane speaks (1846) of excellent specular iron ore (such as that so largely imported from Elba) existing in county Cork, in the Cosheen mines at Skibbereen, and in the Glandore mines at Carberry; and he states that it was not worked, simply for the reason that it was associated with the more valuable ores of copper and manganese, and therefore not worth the trouble. The same anthor gives a graphic description of the clay-iron stones found in the iron mountain of Slieve-a-Nierin, on the eastern shores of Lough Allen, in what has been already referred to as the Connaught coal-field; and he speaks of the vast quantities of ironstone nodules to be had for the picking up, and which have been estimated as sufficient to feed two furnaces for 250 years. A more recent authority, Professor Hull, says, "the claystones of the Leitrim coal-field are intrinsically valuable from their quantity and their richness in iron, and it is to be hoped that they will some day be turned to better account." From analysis, it is known that these ironstones contain over 40 per cent. of metallic iron—a per-centage nearly equal to the best Welsh or Staffordshire ore, while Sir Robert Kane states that the ironstone of the Kilkenny coal-field is scarcely inferior to that of Leitrim, and that the ores of Lough Allen attain a richness in iron only equalled by the celebrated blackband ironstone of Glasgow. There is not the slightest doubt, therefore, but that Ireland, so far from having no iron, is fairly rich in that metal ; and the question naturally occurs—Why is it not worked more than it is ? Why are the Leitrim deposits left neglected, when there is a fortune in them, if properly utilised, and an industry for the whole country side ? The answers are two. In the first place, the chief drawback to utilising the Connaught ores is the want of communication. Lough Allen, in the immediate neighbourhood of which these ores are situated, is isolated, not merely from railways, but almost from ordinary roads ; and it would be difficult to find a more dreary or more sparsely inhabited district than this. But there is a waterway from Lough Allen, down the Shannon, to Carrick-on-Shannon, which is a station on the Midland Great Western Railway, and it would be an easy matter, with a cheap method of transport, to utilise this branch of wealth. The clay band ironstones of the Leinster field are ready to hand, without any difficulties of carriage; while the hæmatites and aluminous ores of Antrim are sufficiently near to the coast to be exported to Ayrshire or Cumberland, where they are held in high estimation for mixing with other ores. In the old days of iron smelting, it was considered necessary, for the profitable smelting of ore, that the ore, the coal, and the limestone flux should all be at hand together; but of recent years this has been entirely revolutionised, and it is now considered the most economical plan to smelt the ores where they are found, and to bring the coal and limestone to them. If, therefore, the Antrim ores are good enough to take to Scotland, they are good enough to be smelted in Antrim, where, too, the proximity of the Ulster coal-field is in their favour. The Connaught ores are actually intermixed with the coal-beds, and the want here is simply some ready means of transport to convey the pig-iron at a moderate rate to its market. The second answer is, that pig-iron has actually been made within the present century at this very spot ; and it was clearly proved, by the careful investigations of Mr. Grieve, in 1800; Mr. (afterwards Sir John) Guest, of the Dowlais Ironworks, in 1804; Mr. (afterwards Sir Richard) Griffith, in 1818 ; and Mr. Twigg, in 1827, that iron of excellent quality could be made here, at a cost not exceeding that of the best Welsh or Staffordshire. The misfortune was, that an undertaking, called the Arigna Iron Company (from the name of the spot), was set on foot in the year 1803, and had a most disastrous career. not from any inherent difficulty of making iron at a profit, but from sheer financial mismanagement. The thing was blundered from beginning to end, the shareholders were ruined, and the prestige of what, under competent direction, would have become a flourishing Irish iron trade, was irretrievably damaged; even to this day the Arigna Iron Company is quoted as the reason why iron cannot be made profitably in Ireland, though the true cause of the breakdown is quite ignored. It may be argued by some, that the iron age is past, and is being supplemented by steel, and that many iron works of good repute in England and Scotland have been obliged to adapt themselves to steel making; but when we see what is being done in the Cleveland district to utilise the low grade ores for steel making by the dephosphorising process, there is no reason why the same process should not be brought into play in Antrim, Connaught, and Leinster, as well as in North Yorkshire.

It has been proved by practical men, that pisolitic ore from Antrim can be smelted at Belfast, with the aid of Welsh or Scotch coal, for £1 17s. per ton, while Cumberland hæmatite costs at least £2 7s. 6d. per ton to produce.

We must not forget to mention the bog iron-ore, which is dug in large quantities in Donegal and other counties, employing several thousand hands. This ore is exported to England as oxide of iron, for the purification of gas.

We are told that in the year 1632 the Earl of Cork had in that county, in his several bloomeries or forges, 1,000 tons of bar iron, besides 103 tons drawn out and fagotted into rods at a slitting mill, and about 2,000 tons of pig-iron. The price of iron at that time was £18 per ton (it is to be presumed, for manufactured iron). In 1629, Luke Brady, of Thomgreny, in the county of Cork, and others, obtained a patent for making iron ordnance shot and cross-bow shot. Iron works were carried on too in the county of Sligo, until all the woods in the neighbourhood were consumed, after which they were transferred by the owner to Foxford, in county Roscommon, where he had others. The cause of the extinction of the trade in those days was the lack of fuel, which of course was charcoal, and it was the same reason that partly killed the brisk iron trade in Kent and Sussex; but the Irish iron ore was there and *is* there, and it becomes more or less a question of transport.

Even granting that the iron trade of Ireland could not compete in the markets of the world with English or American iron, there is a large and unoccupied field in the home trade; for it is not only in raw iron making that Ireland is deficient, but also in the manufactured article. I may mention, as an incidental fact with regard to home trade, that a gentleman in the neighbourhood of Bickley, Kent, wishing to rail round a chapel which he had built, had an offer made to him from Dublin to supply the iron rails and erect them as cheaply, if not cheaper, than he could get them done at home. At any rate, there is plenty of room in Ireland itself for a larger manufactured iron trade, seeing that, according to the returns of 1871, there were only 135 establishments using iron in quantity, and employing 11,227 hands. Of these, 64 were foundries, and 50 were machine shops, leaving but a very small margin for iron shipbuilding, nails, rivets, gun-making, and cutlery.

Copper-mining, once one of Ireland's most valued industries, shows the same retrograde tendency. There are three principal copper-mining districts in Ireland, viz., in counties Wicklow, Waterford, and Cork; and, according to the "Mining Statistics," there are in the first-named district three mines, Ballygahan, Cronebane, and Tigroney, which produced, in 1880, the magnificent aggregate of 52 tons of copper in ore and precipitate, of the total value of £763. Now, in 1836, there were five copper mines in this Avoca (Wicklow) district, yielding 11,813 tons of ore, value £55,818; the Cronebane and Tigroney mines alone, which, in 1880, produced only £416 worth, yielding £23,497 in 1836. In 1840, the Wicklow mines declined considerably in the actual yield of copper; though, on the other hand, the value of the mines, as industrial undertakings, had increased, owing to the development of the iron pyrites trade, as a source of obtaining sulphur. In Wicklow, the copper ore is largely associated with iron pyrites, which was obliged to be raised with it, and thus enhanced the cost; but as soon as an outlet was found for the latter, the extra cost disappeared. According to Sir Robert Kane, there were employed at the Ballymurtagh mine, in 1843, about 700 persons; while the operations, during thirty years, had resulted in dividends over a quarter of a million sterling.

But this happy state of things is bygone, unfortunately, and the mine reports, especially of late years, speak of progressive decline. In fact, the Ballymurtagh mine is idle, and were not the proprietors sufficiently alive to the requirements of the day, by establishing chemical manure and sulphuric acid works at their port of Arklow, this fine industrial property would be a blank. The Waterford group, represented at present by the Knockmahon mine, with a yield, in 1879, of 42 tons, consisted some forty years ago of four mines which yielded in the years 1840 and 1843 nearly 17,000 tons of copper ore, valued at £126,043. The most productive at the present time of the Irish copper mines are situated in the county of Cork, in the promontory of Berehaven, where the Mountain mine yielded in 1880 about 1,470 tons, valued at £7,690, and in the previous year nearly 2,000 tons, valued at £11,200; but this is a bagatelle to the yield of 1836, which was 6,418 tons, of the value of £74,879.

The history of all copper mines, wherever they may be, is more or less one of fluctuation, but at the same time it is somewhat singular that every one of the Irish mines, not belonging to one locality only, but in different parts of the kingdom, should have decreased so systematically. Sir Robert Kane mentions the existence of successful copper workings at Holyhill near Bantry; Ardtully near Kenmare; and Mucross, Killarney, where, by the way, a considerable quantity of very valuable cobalt ore was extracted, and flung away as rubbish. Again, copper, iron pyrites, and lead ore have been partially worked at Silver-mines in Tipperary; at Lackamore, in the valley of the Newport river, Mayo; at Rush, county Dublin; and near Dungannon in Tyrone.

Lead mining is in a somewhat more prosperous condition, or at all events does not show such deplorable contrast to the result of past times. The chief Irish lead mines are at Luganure, county Wicklow, where, at the present date, I am informed by the Secretary of the Mining Company of Ireland, from 1,200 to 1,500 tons of argentiferous galena are being raised. There is no doubt, however, but that large quantities of this metal exist, and have been occasionally worked, such as at Caraghan, county Clare; Caime, Wexford; Derrynoos, near Armagh; Newtownards in county Down; Kildrum in Donegal; and also in counties Kilkenny and Longford.

There are other metals in Ireland, besides copper and lead, which if not so industrially important, are quite worth developing. Oxide of manganese, for instance, occurs at Howth (county Dublin) and at Glandore (Cork), where it is worked to a small extent. Antimony is found in county Clare, associated with lead, and, in the shape of grey sulphuret, at Clontibret (Armagh). Blende or zinc ore, used in the preparation of sulphate of zinc, is worked slightly at Conorree (Wicklow), while Sir Robert Kane mentions that nickel, chrome, arsenic, and bismuth are all known to exist, but that nobody has thought it worth their while to experiment upon them. Before quitting the subject of mineral resources, I should like to mention what appears to be an instructive commentary on this state of things connected with mines and metals, viz., that whereas the gross amount of the annual value of property and profits assessed to the income-tax upon mines in Ireland during 1864 was £55,949, in 1878 it was only £23,209; while that upon ironworks was but £250.

Let us now pass on to another subject, scarcely less important than the last, viz., the clays and rocks, the economical value of which cannot be doubted. There appears to be no reason why pottery on a large scale should not be manufactured in Ireland, seeing that all the materials exist there, and in tolerable proximity to each other, which, after all, is more than Staffordshire can say. It is stated by Kane that the decomposed granite of the Mourne Mountains, county Down, is in every way similar to the china clay-stone of Cornwall, and also that kaolin of the finest quality is obtainable at Baltinglass, Wicklow. Porcelain clay exists in Carlow, though not absolutely free from iron, while clays suitable for the manufacture of the coarser kinds of ware are very plentiful. Between Cahir and Clonmel is an extensive area of pipeclay, quantities of which have been exported to England, though no use of it was made at home, and the same deposit occurs on the shores of Lough Ree, and at Kellymount, county Roscommon. At this latter place, indeed, there was formerly a very prosperous tobacco-pipe manufactory, turning out some thousand gross per week. The fire-clays of the different coal basins are of excellent quality, while those of the Tyrone field contain exactly the same quantity of silica as the Stourbridge clays, though unfortunately they are somewhat marred by peroxide of iron, which would colour the ware. What *can* be done in this direction has been most satisfactorily demonstrated in the case of the Belleek pottery, produced at that place, in the county of Fermanagh, and first established there by Mr. Armstrong. The base of the ware is pure felspar and china clay found in the neighbourhood, and the beauty and grace of the manufactured articles are too well known to need any praise. The pity is, that with such unqualified success, the industry does not rapidly spread. Since the establishment of the Belleek pottery, the whole appearance of the neighbourhood has been altered, the people content and well clothed, and in the receipt of regular and good wages. A remark made by a neighbouring landowner, when on a visit to Belleek, was quoted to me:—"How is it that there are no half-naked wretches making mud pies in Belleek, as there are in the village of Ballinafad?" Mr. Bloomfield, of Castle Caldwell, a landowner who appears to have taken very great pains in developing the material interests of his property, has succeeded in establishing a manufactory of cement, with the double advantage of adding to the industrial resources of the neighbourhood, while producing an article which is of exceeding value, from its property of making dwellings impervious to damp at a very cheap rate; and those who know the climate of Ireland, and the miserable condition of the labourers' huts, will be able to appreciate the substantial gain that such an industry offers. As a matter of fact, there are several localities in Ireland which furnish excellent clays suitable for porcelain, or for the commoner kinds of ware, as also of fine sand, well adapted to the glass trade. The fire-clay of the Kilkenny coal beds is identical with the celebrated fire-clay of Stourbridge, and similar clays are found at Howth, containing 67 per cent. of silica, from which, at one time, crucibles were made with great success. There is no doubt, that if all these deposits were carefully examined, there would be found materials for many important industries.

The same may be said of the building stones of Ireland, many of which are equal to the best in Great Britain. Professor Hull, of the Irish Geological Survey, than whom no better authority exists, states that the Donegal red granite is equal in beauty to that of Peterhead, and capable af receiving a high polish; while those of Wicklow and Down are of a greyish tint, and are extensively quarried at Kingstown, Newry, and Castlewellan. There is scarcely any country in the world which, for its size, possesses greater variety of building marbles of all colours. At Kilkenny, and in the quarries of Galway, there is black marble to any extent, while the latter county yields also white marble, absolutely pure in tint, and, as far as quality goes, of the strongest kind of limestone. Red, yellow, and blue marbles are found in the county of Armagh, purple and white, and blue and white at Churchtown (county Cork), ash-coloured, grey, and dove-coloured at Carrigaline and Castlemary (county Cork); variegated near Tralee; sienna near Shannon Harbour, on the Galway side; fine grey in King's County and Tipperary; striped white and red at Killarney; and brownish-red at Ballymahon (county Longford). Then, again, in Galway and Mayo are quarries of serpentine of the most valuable kind. A recent letter in the *Times* calls attention to the fact that while the red, green, and black marbles of Ireland are largely used, green Irish porphyry is scarcely known; and also that some of the green marbles are of the most lovely colour and quality imaginable, looking like dark green seaweed beneath the clear sea. And yet even Irishmen are oblivious of the rock treasures that lie at their very doors—as witness, for instance, the splendid mansion of Castle Coole, near Enniskillen, built of free-stone brought over from Bath at a fabulous price, though marble of the first quality was to be had for nothing! The slates from Killaloe and Valentia Island are well known and appreciated, as are also those of the Clanwilliam Slate Company at Wooden Bridge, county Wicklow; but there are many other places in which slates are known to exist, even though they are not of such first-rate quality as to compete with North Wales. Sir Robert Kane mentions such at Clonakilty and the Old Head of Kinsale; at Westport, in Mayo; and at Ross, in Waterford. And yet, according to Dr. Neilson Hancock, writing in 1864, the streets of Dublin are paved with Welsh paving stones, and the houses slated with Welsh slates, which, it may be naturally assumed, were preferred because they were better. Judging, however, from the character which the quality of the Irish slates have attained in the market, it seems more likely that the real stumbling block is that of expense, caused by one of Ireland's chief difficulties, viz., the lack of communication and means of transport.

Time will not permit me to enlarge any further on this branch of Irish resources, as I have to deal with many others, and particularly the textiles. The flax and linen trades first of all claim our attention, and the fact of their great success and their world-wide reputation, sufficiently disposes of the accusation so often brought against the Irish people, that they have not the capabilities for becoming a manufacturing race. The statistics of the linen trade, although bearing the stamp of a well-rooted and important national industry, have some points about them which are not altogether so satisfactory as might be, and particularly at the very outset of the trade, viz., the growth of flax, which so nearly touches the prosperity of the farmer as well as the manufacturer.

Looking at the acreage under flax in the various provinces, we find that in 1869 there were in Ulster, 211,044 acres; in Munster, 3,796; in Leinster, 5,258; and in Connaught, 9,080; total 229,178 acres; whereas, in 1880, there were—Ulster, 152,996; Munster, 1,142; Leinster, 2,157; Connaught, 1,239; total, 157,534. These figures show, not so much the stationary or decreasing character of the whole yield, as the apparent failure to grow flax in Munster, Leinster, and Connaught. Ulster always has been, and always will be, the great flax-growing province, and it is as natural that the linen trade should be found in the centre of its supplies, as that an iron-work is found near a coal-field. If there had not been any considerable difference in the yields of the various provinces during the years 1850-80, one would have supposed that there was some barrier to the growth of flax in the nature of the soil; but as we observe that in Connaught, 9,080 acres were planted in 1869, against 1,239 in 1880, this cannot be so. The question, perhaps, is rather one that affects the agricultural than the manufacturing interest, as the latter need not, and does not, depend altogether upon the home supply. The imports of flax, tow, and codilla into the United Kingdom for 1880, were 96,412 tons, of which Ireland took the greatest share; and as the average yield of flax in Ireland for the last ten years is 20,432 tons, it is evident that there is considerable room for the agriculturist to supplement the demand for the trade.

The mistake has often been committed in Ireland of attempting to grow flax on a soil not suitable for the crop, and Mr. Charley, an eminent Belfast authority, mentions that he saw in county Roscommon a soil consisting of a thin clay prepared for flax, with the result, that from 40 to 50 acres a produce was obtained, not exceeding what should have been obtained from 3 or 4 acres of good land. The reason why flax is so successful in county Down, where there were 31,456 acres in 1880, is because the soil consists of a light loam, admirably suited for flax. Geologically, the soils that compose the counties of Down, Antrim, Armagh, Monaghan, Londonderry, Tyrone, and Donegal, consist of lower Silurian, with the igneous rocks associated with them. One may reasonably inquire, therefore, why the same formations in other counties are not more experimented upon for flax growing. If the soils of Tyrone (and this is largely a question of geological chemistry) can grow 24,268 acres of flax, why should Wicklow and Wexford, which consist mainly of the same formation, grow only one acre between them? Of course there may be other reasons which may bar the flax growth, though I am not aware of any; but looking at the question as one largely of soil, it is not unreasonable to suppose that a minute examination of the rocks and soils of the country would greatly tend to the increase of the home flax, and what is more, to the extension of the linen trade from Ulster, to Leinster, Munster, and Connaught.

That the limitation of flax growing and manipulation to Ulster is not due to any physical cause, is evident from a sentence which I have extracted from the "Instructions for the Culture and Preparation of Flax in Ireland," issued by the Flax Supply Association:—"One consideration which should inspire the southern farmers with self-confidence, and stimulate them to grow flax, is *the advantages possessed by them of soil and climate*, which will enable them to produce crops larger in yield, and at a less cost, than is done in the north of Ireland." Dr. Neilson Hancock's testimony is the same with regard to this subject, for he tells us that where experiments have been fairly tried, flax growing has been successful in all the counties of Connaught, in Clare and Kerry, and in certain parts of Cork, Limerick, Tipperary, and Waterford; and he considers that those counties and baronies which have suffered by a decrease of wheat cultivation (particularly counties Clare and Galway), are just the ones which are most likely to prove favourable to the cultivation of flax. What has been done in the west and south entirely bears out this advice, the yield of stones of flax per acre being respectively—Munster 34·80, Leinster 29·90, Connaught 27·90, and Ulster 24·72.

From the statistics of the factory returns, we find that, while in 1871 there were 154 linen factories, these had decreased in 1879 to 144, principally at the expense of the spinning factories, though those for weaving had increased. As regards the machinery, while the spinning spindles in 1881 show a not very large increase since 1871 (the numbers being 879,835 to 866,482), the doubling spindles have considerably decreased (16,194 to 20,166); while, on the other hand, the power-looms have largely increased, being 21,177 to 14,834. In the preparatory machinery, viz., the scutching mills, by which the flax is got ready for spinning, there is a decided decrease, being 1,199 in 1879, against 1,542 in 1869.

In the interests of the trade, it is perhaps as well that this decrease should take place, as the gross produce of the plant is lessened by mill-scutching; while hand-scutching invariably yields more fibre to the acre. Moreover, the reports of the factory inspectors seem to say that the scutching-mills, being in very out-of-the-way country districts, are not very favourable either to cleanliness or morality.

The history of the linen trade, interesting as it is, scarcely comes within the scope of the present paper; but there is one brief episode which it is well to mention, as it bears on an important point in connection with industrial policy. At the early part of the present century there was a Linen Board, which received a Government grant of £20,000 a year, to encourage the extension of the manufacture throughout Ireland, and this Board comprised the leading men in the kingdom, who had the prosperity of the trade at heart. This grant was given up in 1828, and the Board ceased to exist. After that there was a Flax Society, which also had a grant; but that too was given up in its turn. I lately met with an account "of the sums paid by the Linen Board as a bounty to encourage the manufacture of sail-cloth, duck, canvas, and drilling, spun by machinery," and in this account, one Julius Besnard figures, as having manufactured 71,328 yards of sail-cloth in 1805, for which he received £891 12s. bounty, at the rate of 3d. per yard.

Three points are here involved:—1. The system of encouraging a young trade in the shape of gratuity or bounty. 2. The fact that the trade was carried on successfully in Cork. 3. That a branch of the linen manufacture, viz., sail-cloth, was in full play, and is one which might with good reason be encouraged in the present day.

The next textile to which we must direct our attention is that of wool; and here we must briefly touch on its history, for it bears on the possible resuscitation of the trade. Ireland had in times gone by a great celebrity for her wools. Macpherson states that in 1360, stuffs called fays, made in Ireland, were in such request on the Continent, that they were imitated by makers in Catalonia, who were in the habit of producing the finest woollen goods; they were esteemed also in Italy, and were worn by the ladies of Florence, where the luxury of dress was carried to the highest pitch. In 1410, Irish cloth must have been pretty common in England, as we find it charged, equally with worsted stuffs, canvas, and other articles, two shillings per hundred. In 1636, however, Lord Strafford, the then Lord-Lieutenant, thought fit to discourage the woollen trade, although he used every endeavour to increase that of linen. For all that, the Irish woollen trade had become of such importance that even official frowns could not put it down; and the exports of wool, particularly from the south, increased to such an extent as to cause alarm and jealousy on the part of English makers. Cheaper living, we are told, and low wages attracted capitalists from England and the Continent, so that the Irish woollen trade, especially friezes and common cloths, for which it has been long celebrated, defied competition, and threatened materially to control the demand for English products. In 1698, a kind of arrangement was made between the English and Irish Parliaments, by which the latter imposed duties on the export of their own woollens, with the view of buying off English opposition to the linen manufacture. It appears to have been a foolish and one-sided bargain, for the competition on the part of the English linen trade was certainly not checked, while the *coup-de-grace* was given to the woollen industry. The petition from the House of Commons to King William III. ran as follows:—

> "And we do most humbly implore your Majesty's protection and favour in this matter, and that you will make it your royal care, and enjoin all those that you employ in Ireland to make it their care and use their utmost diligence to hinder the exportation of wool from Ireland and for discouraging the woollen manufacture there."

To which the King answered with fatal brevity:—

> "Gentlemen, I will do all that lies in my power to discourage the woollen manufacture in Ireland, and to promote the trade of England."

Acting upon this resolution, a law was passed that very Session, commencing 25th March, 1669, laying 4s. additional duty on every 20s. value of broad cloth exported out of Ireland, and 2s. on every 20s. value of serge, baize, kerseys, stuffs, or any other sort of new drapery made of wool. Thus it was that a trade, for which naturally Ireland possessed all the facilities was thwarted and almost destroyed, though there has been for some years past a tendency towards revival, which deserves the most careful attention at the hands of the Irish landlords and capitalists.

In 1878, we find that there were 73 woollen and worsted factories, with 40,393 spindles; and 411 power-looms, against 61 factories in 1871, having 29,108 spindles and 251 power-looms, while of workers there were 20,545 engaged in the trade in 1871, against 15,675 in 1861; 45,137 in 1851; and 78,090 in 1841. Dr. Neilson Hancock spoke in 1865 of the revival of the woollen trade as a hopeful indication, and, "as it is based on the use of Ireland's natural advantages in wool, water power, and turf (as fuel), the trade admits of great extension, and may, with the rising price of coal in England, very possibly enter into successful competition with the English manufacturers of Irish wool." It is to be hoped that the intentions of Mr. Guinness, as recently stated, to erect a woollen factory at Dublin, will be followed up in other parts of the country, and that also the Marquis of Waterford's reported determination to close his frieze manufactory in that county, in consequence of the treatment that he has received from his tenants, will prove to be only temporary. Of course, the great difficulty lies in the competition of any pure woollen trade with English adulteration in the shape of shoddy, though there is no reason to suppose this difficulty insurmountable.

The cotton trade never was much of a staple of Ireland, and is now in a less flourishing condition than ever it was. There is nothing indigenous, so to speak, in the circumstances of the manufacture, to which the dampness of the climate is doubtless somewhat unfavourable.

The tendency to decrease appears also in the jute manufacture, which, one would have thought, had the same element of success as the linen trade, and yet we find that in 1871 there were five jute factories, and in 1879 only three. True, there were a few more hands employed, viz., 727 in 1871, and 812 in 1878, and it appears from a paper read before the last Social Science Congress at Dublin, that a jute factory, established at Galway in 1867, is exceedingly prosperous, and gives employment to between 400 and 500 hands. This development must be of recent date, as the only jute mill mentioned in Galway, in the returns of 1878, employed 213 workpeople. Many of the subsidiary textile trades have such an unqualified success in Ireland, as regards character of work, that we can only regret that they are so exceedingly localised. The knit hosiery of Balbriggan, for instance, is known and appreciated all over England;

the Irish poplins (a combination of silk and wool) are celebrated throughout the world; while the embroidery on muslin, so largely executed at Bangor and other towns in the district of Ards, county Down, is attaining as high a reputation as the guipure lace of Limerick. These manipulative home industries, as they may be called, appear to flourish in their way, better han factory industries (always excepting those of linen); for in searching the pages of an Irish directory, it is disheartening to come across such statements as, "Ballinakill (Queen's County)—woollen trade decayed;" "Palmerston—flax, oil, lead, and iron trades all gone;" "Edenderry — woollen trade disappeared;" "Kilkenny—woollen cloths and blankets, once very flourishing, but now extinct;" "Moate—linen and cotton, all gone;" "Stradbally—cotton trade disappeared;" "Dublin — tape making, employing 6,000 hands, no longer carried on." Migrations of trade have happened and do happen in every country, but in Ireland they do not appear to have been replaced to any extent by others.

All honour to those landowners who have the foresight to cope with the difficulties, by establishing local industries, such as have been done by Mr. Bloomfield, in Fermanagh, and by Mr. Musgrave, at Carrick, a wild district in Donegal, where a glove-knitting factory is already in active operation, with immediate prospects of a button and power-loom hosiery factory to follow.

Of trades allied to the textiles, there are two which commend themselves to the notice of capitalists, viz., paper and ropes. Of paper mills there are only about 20, and of rope-yards about 28, but a poor condition of two trades that require comparatively little capital, and can be so easily started anywhere. Mr. Richardson, an Irish gentleman, who read a paper on this subject recently at Dublin, called attention to the indigenous grass known as the Purple Melic *(Molinia cerulea)*, which grows with great luxuriance on the edges of bogs that have been partially drained, and which is believed to be exceedingly well adapted to the manufacture of paper. There ought to be no difficulty in experimenting upon it, and if the anticipations are correct, the produce of the grass would go far to pay for the drainage of the bog. *Apropos* of Mr. Richardson's paper, I was particularly struck with the languid interest shown in the subject, confessedly the most important broached at that meeting, both by members of the association, and still more by the Irish press, which seemed utterly insensible to the necessity for practical improvement in their own country.

An important industrial resource which appears to be greatly neglected in Ireland, is that of timber. I do not wish to touch upon agricultural subjects, but can scarcely avoid doing so in this particular case, for it affects the prosperity of the country very nearly. Enormous areas of Irish hill and mountain might be planted with the greatest possible profit, making, to a certain degree, a reproduction of Ireland as it used to be. It was not in ancient days the comparatively treeless land that it now is, for not only do the Irish names repeatedly call attention to the local timbering, such as Altagh Derri, "the grove of oak wood;" Drunagh, "the field of blackthorn," &c., but old writers bear testimony to the dense woods that formerly existed. Dr. Mc'Parlan, in his survey of Leitrim, says, "a hundred years ago, almost the whole country was one continued, undivided forest, so that from Drumshanbo to Drumkeeran, a distance of 9 or 10 miles, one could travel the whole way from tree to tree by branches." Mr. Sampson, in his "Survey of Derry," says that woods extended for 30 or 40 miles in different directions, and the same kind of testimony is given about scores of places in various parts of Ireland. Even the bogs contribute collateral evidence of the plenteousness of the timber, whereas, in the present day, whole counties are treeless, saving perhaps the ornamental wood in some gentleman's grounds, or a stray coppice here and there. The value of forestry, as an industrial resource, in Scotland, England, and all continental countries, is too well understood to need any argument, and to Ireland, the advantages would be twofold: first, to the owners of land, who could scarcely utilise their mountainous possessions better than by systematically planting; secondly, to the people, by furnishing cheap and easily-reached supplies of timber for the many purposes connected with woodwork. Since the gradual substitution of iron for wood in shipbuilding, this outlet is necessarily diminished; but there must be still a large demand for small vessels and coasting craft, and there are hundreds of articles in daily use requiring both the timber and the manipulative skill. For instance, the hoops of butter-firkins are, or were, made of hazel; the ash is in demand for making the firkins themselves; the beech and the maple are both valuable for making the beetling-machines used in the linen trade. It is stated, that hoops for barrels, hayrakes, and even firewood are imported into Ireland from the Continent and America; and, if this is so, there would seem to be a wilful shutting of eyes to the openings for home industries. Although the acreage under timber is slowly increasing, it must be owned that 336,846 acres, out of a total of 15,542,208, is but a very small proportion.

From the timber trade, it is an easy transition to that of shipbuilding, which, at all events in a few places, seems to bring a gleam of light with it. Belfast appears to have secured a firm hold on the shipbuilding interest, a very large share having been obtained by Messrs. Harland and Wolf of that port in building the fleets of the White Star, Peninsular and Oriental, West Indian, Pacific, and other lines. This firm have turned out for Ismay, Imrie, and Co. (the owners of the White Star line) 60,000 tons of shipping, to the money benefit to the town of Belfast of nearly 2½ millions sterling. Though, of course, Belfast possesses exceptional facilities for carrying on such an important industry, other Irish ports might do the same in a modified degree. As a matter of fact, shipbuilding does not appear to increase anywhere except at Belfast.

The next class of industry to which I must refer, viz., that of food products, is of the greatest importance, inasmuch as it deals with a national occupation, as well as with the food supplies for the teeming population of England. Next to the raising and importation of cattle, the two industries most associated with Ireland are those of porter brewing and distilling. They are both necessary and valuable in their way, but it seems almost a regretable circumstance that distilling figures so largely in many towns, to the exclusion of industries of a more wholesome type. This is not the time or place to discuss the subject of temperance in Ireland, but we cannot ignore the fact, that whatever else fails in that country, the whisky trade seems to be always prosperous.

The Irish butter trade is a kind of speciality in the southern counties; but notwithstanding its long experience and hold on the English market, it has considerably suffered of late years from the introduction of more delicate and carefully prepared brands of foreign makers. The question of dairy farming is one that has occupied a large share of public attention of late, and our northern neighbours of Norway, Sweden, and Denmark in particular, have made good use of their opportunities at the various agricultural shows, of exhibiting their excellent systems and introducing their excellent butter into this country. This competition has happily not escaped the notice of the Cork Butter Exchange, and there is every reason to hope that the increased care in Irish butter making will soon result in increased production and consumption. The consumption throughout the United Kingdom, it must be remembered, far exceeds the home production, and our principal supplies are derived from abroad. The import of butter in 1875 was 1,462,300 cwts., and in 1879, was 2,035,391 cwts.; so that it is therefore of the utmost consequence to the Irish butter makers that, in the face of this enormously increasing importation, they should strive to extend their yield, and bring their brands to the highest perfection.

Poultry growing is another branch of agricultural industry which may well attract the experimental farmer, when we consider that over seven million "great hundreds" of eggs are annually sent over from the Continent at the present time. Even as an article of food, the feeding of poultry might be made most profitable; and I remember, when travelling a few years ago in the west and north-west, being particularly struck with the miserable attempts at poultry which constantly figured at the dinner-table, a couple of chickens being by no means too much for a fair appetite, and a single one only big enough for a Barmecide's meal. I am glad to see a tendency towards the increase of poultry; but it is a matter of regret that in the case of another Irish tenant, viz., the pig, there is a corresponding tendency to decrease.

A most serious question is involved in the decline of pigs (from 1,461,215 in 1870 to 849,046 in 1880), for it is, in point of fact, a question of the decline of the Irish provision trade. The last report of the Belfast Chamber of Commerce states that "the curing of Irish products is still largely dependent upon whether seasons are favourable, or the reverse, for the farmer. It seems to be a settled principle with the majority of the Irish farmers in the north, that they will not—perhaps cannot—purchase feeding stuffs for their pigs; and if they have not, off their own land, for nothing as it were, what feeding they require, the young pigs are not reared, and when autumn comes, the deficiency is apparent." Now let us consider, that in Chicago alone there were killed for curing last year 6,280,000 hogs, of which a vast proportion comes to England, and even to Ireland. In 1870, the imports of American hams, bacon, and lard into Belfast alone amounted to 1,917 tons, while in 1880, these imports amounted to 11,174 tons. This shows that the Irish either cannot, or, more likely, will not, grow enough to supply even their own wants, for it is not to be supposed that these imports are not required. An increase in ten years of over 52,00 tons in grain and 9,527 tons of salted meat, besides fresh meat and live animals, into one port alone, is proof at least that the people have an increased purchasing power; and it does seem, with all Ireland's capability, perfectly suicidal to let the field of operations glide from underneath Irish hands, to be grasped firmly by the Americans. There are unequalled facilities in Ireland for establishing a tinned and canned provision trade. But where is it? Where are the Crosse and Blackwells, the Gillons of Leith, the Moirs of Aberdeen, the Libbys of Chicago, to be found in Ireland? The trade in the matter of tinned provisions might be enormous, if undertaken properly—so large that even a subsidiary trade would arise to supply the tin cans. In the matter of fish, the whole population of Great Britain might be supplied with either fresh or tinned fish from the Irish coast, could but those who might undertake the trade be brought to see it, and were proper communication afforded. Some few years ago a preserved milk factory was set on foot at Mallow by a Mr. Newnham; but I have been told that this is no longer in existence. That the article was excellent I know from experience, and there could be no physical reason why a trade such as that of the Anglo-Swiss condensed milk should not spring up. I have been informed that a preserved butter factory is doing well in Queen's County.

A mine of wealth exists in the Irish sea-fisheries, even under the difficulties which beset them, the money-value of the fish sent to England in 1880 being over a million sterling for herrings, mackerel, and cod alone. There is no doubt but that most of the improved conditions of the Irish fisheries arises partly from the working of the Reproductive Loan Fund, which, since its establishment in 1875, has issued in loans over £31,000. Two-thirds of this sum have already been paid back, proving at once the wisdom of fostering the industry by timely help, and giving the lie to assertions that such assistance demoralises the people. A great stimulus to the fisheries has also been given by the erection of piers and little harbours all along the coast. Over eighty of these now exist, furnishing at once a shelter for the fishermen's and other boats, and a nucleus and point of departure for a fishing trade. The greatest want, however, is that which appertains to all industrial undertakings—the want of means to carry the fish to market—for, however productive the fisheries, they are more or less wasted without a ready transport. It is stated that on one occasion 30,000 mackerel were caught in Donegal Bay, which were used for manure, on account of there being nothing at hand, save a few cadgers' carts, to take the fish to the nearest market; and this at a time when mackerel were selling in London for ninepence a-piece. Even the local Irish markets are miserably supplied with fish, and it is almost impossible to get it. I read in the *Irish Times* that a large purveyor in the south, who could have sent tons of fish to Dublin, obtained, net, as his payment, after transport charges and commission, for the finest cod and ling, one half-penny per pound The fact is that the railway system in Ireland does not fulfil its mission, either in quantity or quality of work; and it never will until some individual appears on the scene who will do for the railways what Bianconi did for the public by his well-devised car system.

What is urgently wanted in Ireland, both for fisheries and everything else, is a cheaper system of railway rates, and an extension of cheaply made light railways throughout the country, and especially to the coasts. It is mentioned in the fishery report for 1879, that direct steam communication between England and Greenore was established by the London and North-Western Company in 1873. In 1875, the number of fishing boats which discharged their cargo at that port was 412, but in 1879 had increased to 3,100. If the same railway company were to make a line from their port at Greenore to Donegal and Killybegs, the traffic in fish alone would be something enormous, and the consumers in England would be greatly benefited. Undoubtedly too, the opening up of the country in this manner would bring a considerable amount of money into Ireland, if only in the matter of English tourists and visitors. Donegal, Mayo, Clare, and Kerry counties contain coast and mountain scenery of the highest order, which is far less known to the average excursionist, than the fjords of Norway, or the passes of the Tyrol, and is likely to be so, as long as the commonest form of accommodation, in the shape of railways, steamboats, or decent hotels, is unprovided for those whom the curiosity to see uncivilised lands, tempts into the west of Ireland.

And now, having gathered together all these facts to prove that (1) industries have existed and flourished in Ireland, and (2) that the majority of these industries are not now flourishing, or are extinct, I will very briefly state what I believe may be in time a remedy for this miserable state of things. I offer the suggestions with great diffidence, not that I do not believe in them myself, but because my main object is to rouse individual examination and promote discussion.

Starting therefore with a firm conviction that the Irish difficulty is not one which can ever be solved by political treatment, but that it is one of pure social and industrial economics, I have three propositions to bring forward :—

1. A thorough and exhaustive examination should be made of all the industrial resources of which Ireland may be capable ; her rocks, minerals, soils, trees, grasses, bogs, water, and in fact every natural feature should be minutely observed, in order that we may know what *can* be done, and what *cannot* be done, with the ulterior object of utilising the resources of nature. Many a well intended undertaking has fallen through, simply because it was unsuited to the locality. Let us have some definite answer to the questions—whether the coal of Ireland cannot be won more cheaply or more productively, and if not, why not? whether it is physically impossible that iron should not be smelted there, and why not? what are the reasons that flax is not grown in districts confessed by all experts to be particularly suitable for it ? why cannot the woollen trade be extended ? why is not the utilisation of peat fuel a pronounced success ? with thousands of other questions of a similar nature. If ten or even twenty thousand pounds were expended in this inquiry, every penny of it would bring back its value a hundred thousand fold; and I can conceive nothing more reasonable than that a Royal Commission should be formed to undertake this duty. Millions have been squandered in Ireland at different times, without a tithe of the claims to the national and imperial consideration which this present subject demands; and it is very certain that such a movement, on the part of any Government, would meet with the most cordial reception and assistance in every county, borough, and township in Ireland.

2. Having attained this necessary basis of knowledge, the next point is, how to carry out the development. I am no advocate for sending round the hat, whether for an individual or a nation ; but, at the same time, I think that, under exceptional circumstances, we are justified in applying exceptional rules. Nobody can dispute the fact that Ireland comes under a very exceptional category, and therefore she cannot be judged by the ordinary hard-and-fast doctrines of trade. It is clear that the encouragement of bounty or premium (call it what we will) was the chief cause of Ireland's most successful industry, viz., the linen trade, taking root ; and we are at this moment seeing the improvement that is taking place in the fisheries from the application of this same principle. If it is found good for the State to advance a loan to a local fishery, why should not the State equally advance a loan to help to found a local factory, always supposing that that particular industry has been certified as advisable by the previous examination of the Royal Commission? The cases are identical, and the treatment may therefore be identical. The authorities of our Indian possessions and our colonies pursue a wise discretion, when they offer rewards tending to stimulate invention and develop discovery. New Zealand followed this plan with relation to *Phormium tenax* as a substitute for hemp, and the same thing was done in India (if I mistake not) with regard to the capabilities of the fibre of the *Rheea*. The sugar-making processes in the Mauritius owe much to a stimulus of this kind, and parallel cases may be met with in many other countries. Should something of the kind be done for Ireland, I will venture to say that a solution of many of the vexed points referred to in this paper will soon be forthcoming. Amongst objects of paramount importance, should be the construction of cheap and light railways, and in this matter it may be reasonably expected that the landowners and local magnates, whether residential or absentees, would see the absolute necessity for countenancing them, if only as a matter of self-interest. Such a movement as this would of itself pretty well start an iron trade in Ireland, besides giving work for several years to a large majority of the unemployed, while the advantages of the future, by opening up estates and connecting districts with the sea-board and the fisheries, would give a largely increased permanent value to property. If some such course as this were followed, the ball would be set rolling in the direction of energy and inquiry, and there would be no fear of that demoralisation and pauperising of the people which theorists at a distance, well off them-

selves, are so fond of talking about. Ireland has so far sunk down into the industrial mire, that she *must* be helped out of it, and the only question is, which is the best way to do it?

3. Technical and industrial education must be attended to, so that, simultaneously with the providing of industrial occupation, the workers may be also got ready to understand its value. In schools of science and art Ireland is lamentably deficient, though what is more wanted, perhaps, than science and art schools, are elementary trade schools, or at all events a course of trade classes added to the existing system. Even considering agriculture to be Ireland's chief industry, it is surprising that there is no veterinary college in Dublin, and that the class books used in the national schools contain no text-book on agriculture or horticulture.

These, then, are the chief points in which I consider that Ireland's prosperity is most involved. Right or wrong, I do at all events trust that the attention of thinking men will be attracted to this most important national subject.

DISCUSSION.

The CHAIRMAN said that there was a great deal of useful information in the paper, but at the same time he could not but feel that it was a very melancholy one, for it told of decreasing prosperity, and of the decay of many industries in Ireland, and he was sorry to say that the story was not at all a pleasing one for Englishmen to hear; for instance, the cold water thrown on the woollen trade by this country was a very unpleasant remembrance. But though he heartily wished that all the industries spoken of could be encouraged and developed, he must say, and he said it with deep regret, that until Irishmen learned the homely virtues of thrift and industry, and respect for the law, it was quite impossible for capital, which was the great want of Ireland, to be introduced into that country. Of all things in the world capital was the most timid; and who would be at present disposed to embark capital in any industry in Ireland. He was rather amused when Mr. Bevan spoke of the decrease in the trade in pigs, and of what Chicago was doing in that line, for he had been lately reading an account of Chicago, which showed that that State exported yearly six millions of hogs, and it was further stated that a pig was killed, skinned, and cured in fifteen minutes. That showed something like enterprise. Without capital no industry, no farming, no manufacture, could possibly thrive, and until Ireland was settled and peaceful, more capital would not flow into it. He was sure there was no one but would be thankful to see Ireland restored to prosperity and peace, and he hoped they might live to see it, but at present the prospect was very dark.

Mr. QUINLAN said every one who had the welfare of the United Kingdom at heart must feel grateful to Mr. Bevan for bringing forward this subject, for the prosperity of Ireland was of the greatest importance to England. As long as people were poor, they were always discontented. He had studied this subject in Ireland, having lived in every part of the country except Connaught, and had striven to answer the question, why her industries were not developed. He had seen an industry prosper in Ulster, and in Munster the very reverse, and had endeavoured to find out the cause. It was generally said, at the time, that it was owing to the laziness and incapacity of the people themselves; but that he found was not so, for his own experience, both in Ireland and America, where he had seen these men working hard and successfully, and also in London for a great number of years, where he had had Englishmen, Irishmen, Scotchmen, and Welshmen working under him, was that the Irishmen worked as well as any one else, when they had a fair expectation of a profitable return. What, then, was the cause? One reason was the want of capital. In this country new enterprises were constantly being started, because the people were prosperous and accumulating money, for which they wanted an investment. Of course they ran the risk of making a loss, but being well off, they could afford to speculate. Why was it that in Ireland there were none of these joint stock enterprises? After some inquiry, he found the answer was plain enough. There was a constant drain going on which no country could stand; that drain amounted to twenty millions per annum, either in rent to absentee landlords, or in imperial taxation, which was not returned. How could anyone expect the national resources to be developed under such circumstances. What would twenty millions a year do, if poured into the country for investment? It was pretty clear to him that as long as that drain existed, there was very little chance of any sort of profitable speculation. When people were comparatively poor, when their savings were only small, they were extremely cautious what they did with them. If a man had large capital he would run more risks; but if he had worked extremely hard, and had only saved a little, he would not put his money into iron or coal mines which were risky, but would either hoard it, or put it into a bank at very small interest, which was the next thing to hoarding. Then there was another reason. If a man with small capital started in trade, in competition with a man of large capital, he had very little chance of succeeding. He himself happened to be connected with some large enterprises, one in particular, in which the turnover was £100,000 a year, and on that they made a good profit; but if it was only £50,000 they would make nothing. Now, in the case of manufactures, Ireland had England as a powerful competitor, with large capital, experience, its markets made, and scientifically acquainted with the methods of doing business; in Ireland there were no manufacturers, and no trade;

there were not the men there to make them. You could not go into any neighbourhood you thought suitable and start a manufacture unless you had skilled workmen; anyone who had ever had the management of a large business, and whose staff had from any cause been broken up, knew the extreme difficulty of starting again. What, then, was the remedy for all this? It appeared to him that Ireland was very much in the position of a body of shareholders without a board; or rather, considering what she had gone through—the rebellions and revolutions, and the breaking up of society of every rank and class—she was in the position of a man just recovering from a severe illness, who wanted to be nursed and doctored. You could not expect a country, any more than an individual, under such circumstances, to become at once strong and vigorous; it was somewhat like a new country, and wanted its industries fostered. There was no firmer believer in free trade than he was, but, just as a convalescent required nursing and assistance, so a country in such a position required its industries to be nursed and encouraged. He believed what was wanted was a kind of Central Board, whether it were called Home Rule or any other rule; but he should rather call it a Board of Directors, whose special business should be to inquire into the resources of the country, and how they could be turned to the best advantage, and how the people could be educated up to the point of being able to successfully compete with others. He did not agree with the Land Bill altogether, but it was a matter of the greatest necessity that the rent should be reduced; whether the landlords should be compensated or not was a question of politics, which he would not deal with, but one good effect would be that it would reduce the amount of money going out of the country to absentee landlords. Still, something more was wanted, and he did not believe that until there was some such Board as he had referred to established, there was any possibility of the country getting out of the position in which it was. With regard to Irishmen not buying their own productions, the real cause generally was that architects and engineers nearly always specified the brands of iron, and so on, that were to be used, thus Scotch and English goods were employed when Irish would do just as well.

The SECRETARY read the following letter from Prof. Leone Levi:—

5, Crown-office-row, Temple,
11th January, 1882.

DEAR SIR,—I am exceedingly sorry that a previous engagement does not permit me to be present this evening and hear the able paper on "The Industrial Resources of Ireland," by Mr. George Bevan. Though recent troubles have cast an unhappy shadow on Irish industry, I am happy to say, that as far as I can gather from well-established facts, the economic condition of the country, apart, indeed, from the uncertain results of the annual harvests, has been for years greatly improving. In 1859-60, the amount assessed and income-tax under Schedule D, was £4,892,000, or at the rate of 16s. 9d. per head of the population. In 1879-80, the amount to be assessed was £6,987,000, or at the rate of £1 6s. 3d. per head. The capital of the savings banks in 1859-60 was £2,143,000, or in the proportion of 7s. 4d. per head. In 1879-80, the capital was £3,656,000, or in the proportion of 13s. 8d. per head. The balances at bankers, which in 1861 were £14,388,000, in 1879 amounted to £30,191,000. The main resources of Ireland are agricultural. There the Irish might greatly advance. In manufactures Ireland has not much chance, in consequence of the greater costliness of fuel, and the distance of the market. How far the question of race comes into play I am not able to judge, but it is a fact, that whilst in the north, where there is a great admixture of the Saxon elements, there is comparative prosperity, in the south and west, where the Celtic is more prominent, there is comparative lassitude and poverty.—I am, dear sir, yours faithfully,

LEONE LEVI.

Trueman Wood, Esq.

Mr. H. MONCRIEFF PAUL said Mr. Bevan had accounted in some degree for the want of development of Ireland's industrial resources, in the first place by the decrease in the population. That was very remarkable, but it occurred mainly in two periods, from 1841 to 1851, and from 1851 to 1861. In the first decade that arose from the Irish famine, and the emigration which followed it, and in the second, in great degree by the attraction of the Californian and Australian gold-fields. Mr. Quinlan had said that, in his experience, Irishmen worked as well as any one else, provided there was an inducement for them to do so, and that was a great point in the Irish working-man's character. He was of a somewhat speculative nature, and wanted to work for himself, if by contract work, or at the goldfields, he saw a chance of making good returns; that suited him better than plodding on steadily at a low rate of wages, in the hope of accumulating a considerable sum by his savings. With regard to wool, he was glad to see that Mr. Bevan had realised what shoddy had done in displacing the trade. It was well known that, in Yorkshire, shoddy was an important ingredient now-a-days in many cloths sent forth to the world; but in Ireland this manufacture of shoddy had not been stimulated to the same extent, and therefore the more honest Irish woollens had to compete with those of Yorkshire, in which shoddy played so large a part. Another element of competition with which Irish wool had to contend, was the increase of colonial wool of a light type. On looking into the figures he found that, whereas in 1872 only 7½ million pounds worth of wool was imported from the Australian colonies, in 1881 the value reached £56,000,000; or, putting it in another form, in 1872 there were in Australia 1,750,000 coarse bred sheep, while in 1881 there were 13 millions; whereas in Ireland the return in 1867 showed the number of sheep to be 4,826,000; in 1872 they had decreased to 4,262,000; and in 1877 to 3,989,000. The natural inference was, that as the sheep had decreased, the amount of wool and woollen manufactures must have decreased also. With regard to food products, such as butter, hams, and bacon, no doubt Mr. Bevan was quite correct, that Ireland had been much interfered with by the improved production of other countries, including the North of France. Ireland had also lost a large outlet, which previously existed, for her butter, in the Australian colonies, which now produced their own, and were trying to export it to England. With regard to hams and bacon, America possessed the immense advantage of being able to feed pigs cheaply with maize; in fact, the export of bacon from America was simply a compact way of exporting maize. No such advantage was possessed by Ireland, and she would have to import food for pigs if they were to be raised there on a large scale. Mr. Bevan advocated the giving of premiums to stimulate Irish industry, but he feared that would be hardly compatible with free trade, and thought Ireland was already sufficiently protected by the expenses of transit, which her competitors had to submit to. Nor, he thought, would Ireland like to be considered an infant, which required rewards of this nature. The instance of New Zealand flax which had been mentioned was of a very different character. The *Phormium tenax* grew wild there, and was a very great nuisance, and the rewards offered by the Government was with the view of producing some means by which the colonists would be able to clear their lands of what was quite a pestilence. The efforts made in that direction, however, were not so successful as might have been expected, and there were vast areas there now covered so thickly with the *Phormium tenax*, that you could not ride through it without clearing a passage.

Mr. W. Martin Wood said he had heard Mr. Bevan once before on this subject, and he was sure no apology was needed for bringing it forward a second time. The facts brought forward were very discouraging, and all the more so that one could scarcely find any point of resistance—any fulcrum from which an upward movement might be expected to arise. But that was not a place where any discouragement should be acknowledged, and he hoped, at any rate, the paper would do something towards aiding the project for an exhibition in Ireland, which, no doubt, would be very beneficial. Notwithstanding the statement that Irishmen would not use their own manufactures, it was quite evident that many of them wished to do so, and that was one way in which the thing could be pushed forward. It appeared to him there was a strong analogy between the state of things in Ireland and in India, many of the circumstances being very similar, especially the great want of capital. They all agreed there was a great drain, but he thought it must be an exaggeration to put the figure at 20 millions, and, at any rate, it must be a mere flea-bite compared to the drain from India. Another feature, common to the two countries, was the great denudation of trees; and in connection with that subject he might call attention to a paragraph which lately appeared in the *Pall Mall Gazette*, quoting a letter, written by the late Mr. Carlyle, some 20 years ago, in which he advised the eight millions of people in Ireland each to plant a tree, and discanted on the manifold blessings which would thereby arise. If anything could be done in that way on a large scale, it would eventually be most productive of good. Mr. Bevan had also pointed out the great need for improved communication, and the inadequacy of the railway system. What was wanted in a country like Ireland, was more water communication, by which alone could bulky products be conveyed cheaply. He thought the suggestion of an inquiry into Ireland's industrial resources was a very good one.

Mr. H. Clements believed that Irishmen would be as thrifty as Englishmen under similar circumstances, but hitherto those conditions had not prevailed. In Ulster they were thrifty, because there was an encouragement to spend money on the land; but this was not so in other parts, where improvements only offered an excuse for raising the rent. He believed when the people understood that their industry would benefit themselves, the law would be obeyed. When the country became more prosperous, there would be more railways; but it was no use making them until there was traffic to support them; those now existing did not pay. The late Lord Lieutenant, Earl Spencer, gave prizes to encourage the farmers to improve the cultivation, and very good results ensued in Ulster; many of the people had no idea of the proper rotation of crops, or how to breed and rea animals. Mr. Bevan was in error in stating that there were no text-books on agriculture, for there were one or two published by the Board of National Education. There was great hope for an improvement in the butter industry, for there was a travelling dairy now going about, making great efforts to improve the quality of the article.

Mr. Ablett said that the planting of trees might be carried out without much trouble or expense, particularly in marshy districts, as he had pointed out in a recent letter to the *Times*.

Mr. Liggins thought this paper would do a great deal to dispel from the minds of Irishmen the idea that Englishmen entertained any unkind feelings towards their country. Irishmen might be assured that they all desired the happiness and prosperity of the sister isle, and the more so as they were determined to keep it the sister isle. There was a root to all evil, as well as to all good, and he believed there were in Ireland two great evils which were beyond the power of man to control. One was that the west and south of the country were denuded of soil, and possessed a poor miserable sterile land, quite incapable of supporting a large population. He had formed that opinion from personal observation; for many miles between Cork and Killarney it was quite incapable of supporting a population of pigs, and that was one reason why the pig trade of Ireland could never compete with that of America, as carried on upon the fertile lands of the Western States, which he was also acquainted with. The other evil was that there was so much moisture that they could not be sure of ripening corn, and therefore had to depend on inferior crops. Thirty years ago or more, his father, with other gentleman interested himself in establishing a sugar manufactory near Dublin, which was furnished with the best machinery which the ingenuity of various countries could at that time produce, and most excellent loaf sugar was produced; but it failed because the Irish farmers would not grow the beet-root with which to make the sugar. They said the climate and soil did not suit the beet-root; but chemical analysis showed that the soil was of the same nature as that which was most suitable for it in France. It was pleasing to see what the *Times* said when it recorded that Messrs. Harland and Wolf had turned out the first steel sailing ship which had been built in Ireland over 2,200 tons measurement; but that was not the first iron ship built in Ireland. He remembered going down to the East India Docks some thirty years ago to see a very large ship which was built at Londonderry; she was very successful as a ship, but she was not successful in making a fortune for the town that produced her. Messrs. Harland and Wolf would have a name as long as the names of shipbuilders were honoured, from the success of these magnificent ships of the White Star line, which had been running for some time to New York, but he rather questioned if half the steel and iron used in those ships was produced with Irish coal and iron; he believed a great deal of it came from the Bessemer Works at Barrow. The people of Ireland were industrious, but there was a want of capital to enable them to compete with their rivals in the market. It was Irishmen who raised the pigs and brought to a successful issue that enormous trade which he had seen in Cincinnati, but it would be always impossible for Irishmen at home to compete with such fertile soil as that of America. The fisheries of Ireland had been mentioned, but there was one very serious objection to the transit of fish from thence to the Liverpool and London markets, and it was an Irish objection. The Irish could not be satisfied to follow England in making their railways, but had a gauge of their own, which prevented the through-running of trucks, and fish would not bear change of carriage. That had been pointed out very clearly by Mr. Scott Russell. The North Sea was the great fishing ground for London, from which the best went to Paris, and also to Manchester and other places. The carriages was much cheaper from the North Sea than it ever could be from the west coast of Ireland, though there was plenty of fish there.

Mr. TREWBY wished to give the reason why flax was grown in one part of Ireland and not in others. Some time ago, a company was brought out, called the National Flax Company of Ireland, and they stated the reason to be that in some parts there were no retteries, or factories for retting the flax straw, but if they were established, the growth of flax would at once commence. They only wanted £20,000 to establish forty factories, but capitalists did not come forward, and the project fell to the ground. He believed they might take a great deal of comfort from the present movement in Ireland, For the last thirty years Irishmen had been looking to America as their home, feeling that Ireland was "no longer fit to live in;" but now they were fighting for their land, which showed they meant to stop there, and make the most of it.

Mr. BEVAN said the remarks which had been made were so much in accord with his own views that he had scarcely anything to add. With regard to establishing retteries to promote the growth of flax, it was rather putting the cart before the horse; if flax were grown, the retteries would come, but one could scarcely expect capitalists to go and build retteries where there was no flax to ret. The way would be for some farmers and capitalists to meet together; and if the farmers said we will grow the flax if you will find the capital to ret it, no doubt it would be done, and the linen trade would follow. He had done his best to get at trustworthy facts, though he was quite sensible that the paper was very crude, and it was quite possible he might be wrong in some of the conclusions he had arrived at. He had no interest in the matter commercially or sentimentally, except that being of Celtic extraction himself, he had sympathy for other Celts. But he could not help seeing that this was a question with which the interests of England were bound up, and it ought to be discussed without any bias of race, character, or politics. To a certain extent, it was a question with which the Government must interfere, but the great mistake had been that Ireland had been treated solely as a political battle-ground, and it had been an immense evil, not only to Ireland, but to England also, that successive Governments of all denominations for the last fifty years had agreed in thinking that Ireland was to be treated with political nostrums.

The CHAIRMAN then proposed a vote of thanks to Mr. Bevan, which was carried unanimously.

General Notes.

NAPHTHA AS FUEL FOR LOCOMOTIVES.—Some experiments have lately been made, by the administration of the Tsarkoe-Selo Railway Company, for burning naphtha as fuel in locomotive engines. A tray of cast-iron is fitted in the ordinary fire-box of the engine over the bars, and above this tray is fixed a grating of wrought-iron pipes placed crosswise, and perforated with a number of small holes on the lower side. These pipes communicate, by means of a larger one, with a tin cylinder placed in the tender. This cylinder is divided into two unequal compartments, one containing water and the other naphtha. The flow of these liquids from the two compartments into the funnel-end of the pipe leading to hollow grating in fire-box, is regulated by a valve; the water acts as a pulveriser, and separates the stream of naphtha, and in this way a larger quantity of air is brought into contact with the fuel, and the combustion in consequence is more rapid, and heating power increased. The engine experimented on gave excellent results, and the railway company have applied to Government for authorisation to use this system of heating on train lines. The use of naphtha in some parts of Russia will be more economical than either coal or wood.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

JANUARY 18.—"The Relation of Botanical Science to Ornamental Art." By F. EDWARD HULME, F.L.S., F.S.A. Sir PHILIP CUNLIFFE OWEN, K.C.M.G., C.B., C.I.E., will preside.

JANUARY 25.—"The Causes and Remedies of Bad Trade." By WALTER R. BROWNE, M.A. Lord REAY will preside.

FEBRUARY 1.—"Stained Glass Windows." By LEWIS FOREMAN DAY.

FEBRUARY 8.—"The Manufacture of Ordnance." By Colonel MAITLAND. Sir FREDERICK BRAMWELL, F.R.S., Chairman of Council, will preside.

FEBRUARY 15.—"The Teaching of Forestry." By Colonel G. F. PEARSON. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., will preside.

FEBRUARY 22.—"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON.

MARCH 1.—"Secondary Batteries." By A. DE MERITENS.

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S.

Dates not yet fixed:—

"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A.

"Telephonic Communication." By Lieut.-Col. C. E. WEBBER.

"The High-pressure Steam-engine." By LOFTUS PERKINS.

"Tonnage Measurement." By ADMIRAL SIR R. SPENCER ROBINSON, K.C.B., F.R.S.

"Tools and Cutting Edges." By D. A. AIRD.

"The Art of Turning." By P. W. HASLUCK.

"Gas for Lighthouses." (Illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

JANUARY 31.—"The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By WILLIAM COCHRAN.

FEBRUARY 7.—"Notes on the Trade Capacities of Newfoundland." By E. HEPPLE HALL.

FEBRUARY 28.—"The Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. NOEL SHORE, author of "The Flight of the Lapwing."

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APRIL 25.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Moscow.

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

APPLIED CHEMISTRY AND PHYSIC SECTION.

Thursday Evenings, at Eight o'clock:—

JANUARY 26.—"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By Dr. THUDICHUM.

FEBRUARY 23.—"Photometric Standards." By HAROLD DIXON. Dr. A. W. WILLIAMSON, F.R.S., will preside.

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON.

APRIL 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS and PERCY C. GILCHRIST.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

JANUARY 13.—"The Opium Trade." By Sir RUTHERFORD ALCOCK, K.C.B. Lord ABERDARE, P.R.G.S., will preside.

FEBRUARY 17.—"The Depreciation of Silver as it affects India." By J. M. MACLEAN.

MARCH 17.—"Village Life, and the Village System in the Bombay Presidency." By W. G. PEDDER.

APRIL 21.—"The Mineral Resources of India, and their Development." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

MAY 5.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 26.—"The Production of Tea, Cinchona. Rhea, and Wild Silks in India." By J. R. ROYLE,

[There will be no meeting on March 31, as previously announced, but one will be held on May 5 instead.]

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Second Course will be on "Recent Advances in Photography." By Captain ABNEY, R.E., F.R.S.

LECTURE 1, JANUARY 30.—Introduction. Direct action of light. Action of light and development. Daguerrotype. Phenomena met with in photographic experiments.

LECTURE 2, FEBRUARY 6.—The effect of the spectrum on the different molecular forms of the silver haloids. Practical applications. Sensitisers considered. Sensitiveness of the different salts of silver. Sensitometers considered.

LECTURE 3, FEBRUARY 13.—Dry plate processes. Instantaneous pictures. Instantaneous shutters. Enlargements, direct and otherwise produced. Colour of developed prints. Applications of photography science.

LECTURE 4, FEBRUARY 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 16...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Resumed discussion on Mr. E. P. Squarey's paper, "Land Legislation and Tenants' Improvements," and on Mr. P. D. Tuckett's paper, "The Cause and Failure of the Agricultural Holdings Act of 1875, and the Present Agitation for Protection for Tenants' Capital."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. Joseph Thomson, "A Recent Journey through the Rovuma Country." 2. Rev. Chauncy Maples, "Makua Land, between the Rivers Rovuma and Luli."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C. 8 p.m. Rev. H. G. Tomkins, "Biblical Proper Names, personal and local, illustrated from sources external to Holy Scripture."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. E. Ray Lankester, "Scorpions; Terrestrial and Marine."

Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. Dr. Alexander E. Miller, "Reform in the Lunacy Laws."

TUESDAY, JAN. 17....Royal Institution, Albemarle-street, W. 3 p.m. Prof. J. G. McKendrick, "The Mechanism of the Senses." (Lecture 1.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Renewed Discussion on "River Conservancy."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Professor Leone Levi, "The Economic Progress of Italy, during the last Twenty Years since the Establishment of the Italian Kingdom."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1 Mr. W. K. Parker, "The Structure and Development of the Skull in the Crocodilia." 2. Mr Oldfield Thomas, "A Collection of Rodents from North Peru." 3. Mr. T. E. Buckley, "The Variability of Plumage exhibited by the Red Grouse."

Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., at 8 p.m. Mr. James R Saunders, "Natal in its Relation to South Africa."

WEDNESDAY, JAN. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr, F. Edward Hulme, "The Relation of Botanical Science to Ornamental Art."

Meteorological, 25, Great George-street, S.W., 7 p.m. Annual General Meeting. President's Address.

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. H. Syer Cuming, "St. Agnes' Eve." 2. Mr. Thomas Morgan, "Romano British Mosaic Pavements."

Society of Public Analysts, Burlington-house, W., 5 p.m. Annual Address by the President. 1. Mr. A. Winter Blythe, "A new method of Testing for Alum, with Experimental Illustrations." 2. Mr. J. Carter Bell, "The Manufacture of Chloride of Sulphur."

East India Association, 14, Bedford-row, W.C., 8 p.m. Mr. Edward J. Watherston, "Indian and other Foreign Productions in Gold and Silver Plate, and why they are virtually prohibited from importation into the United Kingdom."

THURSDAY, JAN. 19...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Geo. Maw, "Life History of a Crocus, and Classification and Geographical Distribution of the Genus." 2. Mr. W. Percy Sladen, "Asteroidea of *Challenger* Expedition." 3. Rev. George Henslow, "Staminiferous Corolla in *Digitalis* and *Solanum*."

Chemical Society, Burlington-house, W., 8 p.m. 1. Mr. C. F. Cross and Mr. S. J. Bevan, "Researches into the Chemistry of Bast Fibres." 2. Mr. A. Higgin, "Dibenzoyl Aniline and its Isomerides." 3. Mr. C. F. Cross and Mr. S. J. Bevan, "A New Apparatus for the Determination of Melting Points." 4. Mr. W. N. Hartley, "Contributions to the History of Cerium Compounds."

London Institution, Finsbury-circus, E.C., 7 p.m. Dr. W. H. Stone, "Singing, Speaking, and Stammering."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. N. Moseley, "Corals." (Lecture I.)

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. C. Street, "Foundations."

Telegraph Engineers and Electricians, 4, The Sanctuary, S.W. Inaugural Address by the President, Lieut.-Col. C. E. Webber.

FRIDAY, JAN. 20....Royal Institution, Albemarle-street, W., 8 p.m. Weekly meeting, 9 p.m. Dr. W. Huggins, "Comets."

Philological, University College, W.C., 8 p.m. Dr. J. A. H. Murray, "A Dictionary Evening."

SATURDAY, JAN. 21....Royal Institution, Albemarle-street, W., 3 p.m. Mr. Ernest Pauer, "Louis Van Beethoven." (Lecture I.)

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FRIDAY, JANUARY 20, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

The Exhibition of Photographic Appliances, in connexion with Captain Abney's Cantor Lectures on "Recent Advances in Photography," will be opened on the day of Captain Abney's first lecture, January 30th. The Exhibition will be kept open from January 30th till about the end of February, every day from ten to four, and on Monday and Wednesday evenings from six to eight. Notice has been issued to all the intending exhibitors that their apparatus, &c., should be sent in on Monday next, the 23rd inst.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

Persons not members of the Society, who are interested in Photography, may obtain tickets on application to the Secretary.

More than eighty contributors have promised to send apparatus, &c., for exhibition. Messrs. Siemens Brothers have kindly undertaken to lend a dynamo-machine and lamp, while Messrs. Crossley have been good enough to lend a gas-engine, by which the machine will be driven, so that the electric light may be available for purposes of experiment.

Arrangements have been made for showing the actual working of some of the more recent printing processes, and it is probable that illustrations may be given of photography by various artificial lights.

A catalogue of the exhibits will be published in the number of the *Journal* for February 3rd, and will also be printed separately.

THE PARCEL POST.

The following letter from Mr. G. C. T. Bartley has been received by the Council, and is now under consideration :—

St. Margaret's-house, Victoria-street,
Westminster, S.W., 7th January, 1882.

Gentlemen,—The subject of a parcel post is one in which the Society of Arts has always taken a deep interest, and the gradual growth of public opinion concerning it is no doubt due, in no small degree, to the action of the Society. It seems to me, and I have reason to believe also, to many other members of the Society, that the present is a very suitable time for taking important action with a view to securing this much and long needed reform. The correspondence which has lately taken place in the public press shows that our mercantile and trading classes are keenly resenting the difference which exists between the facilities for the transmission of parcels afforded in Germany and Switzerland, and the difficulties which they meet with here. Several cases have lately been made public in which it has actually been cheaper for traders to send their parcels abroad, in order to post them there as parcels to be delivered by post in this country and the colonies.

I would, therefore, urge that the Council take immediate steps to advocate the formation of a parcel post, which shall be at least as convenient as that now in use in Germany and Switzerland. That efforts be made to secure that such parcel post be international. The means I would propose are that the Council should organise deputations consisting of the Council of the Society, and as many members of both Houses of Parliament as belong to the Society, and other persons of influence, who shall wait first upon the Postmaster-General, secondly on the Chairman of the Railway Clearing-house, and thirdly on her Majesty's Treasury, in order to advocate the formation of a parcel post.

The action of the present Postmaster-General in promoting all measures which tend to extend the usefulness of his department, together with his openly expressed opinion on the subject of a parcel post, render the present an extremely opportune time for the Society to take active measures in this direction.

I have the honour to be, Gentlemen,

Your most obedient Servant,

(Signed) George C. T. Bartley.

Proceedings of the Society.

CANTOR LECTURES.

SOME OF THE INDUSTRIAL USES OF THE CALCIUM COMPOUNDS.

By Thomas Bolas, F.C.S.

Lecture III.—Delivered December 4th, 1881.

Sulphate of lime and its occurrence in Nature. Gypsum and alabaster. Plaster of Paris, its preparation and uses. Physical and chemical aspects of the setting of plaster. Accelerating and retarding influences. Scientific principles involved in some of the applications of plaster. Moulding, stereotyping, and other processes.

The sulphate of calcium, although it is neither so abundant nor so important from an industrial point of view as the carbonate, has properties which are perhaps more interesting and noteworthy in themselves.

Sulphate of calcium is perhaps as widely diffused as the carbonate, being present in almost all spring waters and soils, but we do not meet with compact masses of the sulphate which are at all comparable in magnitude with the larger deposits of calcium carbonate. In some instances, the sulphate and the carbonate occur together in the same mineral, as in the case of the so-called montmartrite, which is so abundantly found in the neighbourhood of Paris.

Sulphate of calcium occurs in the anhydrous form, that is to say without any water of crystallisation, as the mineral anhydrite; but this occurs so sparely as to be of no industrial importance. When combined with two molecules of water of crystallisation, it presents the various forms of gypsum or plaster stone; among which may be mentioned the earthy or almost amorphous varieties; the clear and nearly transparent forms, often known as alabaster; the fibrous kinds, and that which is crystallised in flattened prisms, and is known as selenite. A very complete collection of specimens of the various kinds of gypsum or sulphate of lime, as found in various parts of the world, are on the side table yonder; many of these having been kindly supplied by the Director of the *Société des Plâtrières Réunies*, of Paris; Messrs. Bellman and Ivey, Messrs. Dennett and Ingle, and others.

In this country, the principal deposits of calcium sulphate which are useful industrially occur in Nottinghamshire, Leicestershire, and Derbyshire; but notable quantities occur in Cumberland, and smaller deposits in Sussex, Kent, and Somerset. Few countries are without tolerably large deposits of gypsum in one form or another, and Switzerland, the Tyrol, Sicily, the United States, and some of the South American districts being notable in this respect. Apart from these localities, the immediate neighbourhood of Paris stands preeminent; but the gypsum found there usually contains over 10 per cent. of carbonate of calcium, not, as a rule, in intimate union with the sulphate, but interspersed in the form of grain. This carbonate gives the Paris plaster some of its most useful properties as a constructive material.

The flat crystalline prisms, like the amorphous masses of gypsum, contain $Ca\ SO4 + 2\ H_2O$, and if you reckon this out, it will correspond to nearly 21 per cent. of water. Sulphate of calcium is soluble in about 525 parts at the freezing point, and in 466 parts of water, at a temperature of 38° Centigrade. As the temperature is elevated above this point, the solubility of the sulphate of lime diminishes until, at a heat of 150° Centigrade, it becomes almost insoluble. The presence of certain saline bodies notably increases the solubility of sulphate of calcium in water; sodium chloride, or common salt, to a moderate extent; while sodium hypo-sulphite increase the solubility of the gypsum about eight-fold. This circumstance gives chemists a useful method for effecting the analytical separation of barium and calcium. The crystallisation of gypsum from warm water, or from water containing a little hydrochloric acid, is a pretty experiment, and as the solution in this globe cools, you will see fine needle-shaped crystals of the hydrated sulphate shoot out, and form tufts nearly resembling the crystals of sulphate of quinine. These crystals make an admirable material for the loading of paper, as they possess a certain amount of strength or toughness themselves. Here is a sample of the hard and stony sulphate of calcium, which separates from water when it is evaporated in a steam boiler, and you know well how severe accidents frequently happen through the undue accumulation of such incrustations. In connection with this matter, you will not forget that at a temperature of 150° Centigrade, sulphate of calcium is nearly insoluble in water.

Sulphate of calcium is readily obtained in a state of purity by precipitation, when a soluble calcium salt is mixed with a sulphate in solution. Here is a moderately dilute solution of calcium chloride, to which will be added some sodium sulphate; and after a few minutes the deposition of the calcium sulphate will commence, the precipitate consisting of minute needles, similar to those obtained by deposition from warm water, but somewhat smaller. Sulphate of calcium fuses at a bright red heat, and on cooling assumes the crystalline state.

One of the most remarkable circumstances in connection with sulphate of lime is the fact that when the crystals are heated sufficiently to drive off two-thirds of their water, that the residue possesses the property of rapidly setting or hardening when mixed with somewhat more water than that which was originally driven off. In this case it appears that chemical union with the added water takes place, and that the original body, $Ca\ SO_4 + 2\ H_2O$ is reproduced.

Here is a glass retort which is partially filled with coarsely powdered gypsum, and you will see that when a gentle heat is applied by means of this gas burner, that a large quantity of water will distil over. A heat of 120° Centigrade is sufficient to drive off about three-fourths of the water, and in preparing plaster it is necessary that the heat should not exceed 250° Centigrade, as good quick-setting plaster should retain five per cent. of water, and have a composition nearly corresponding with the formula :—

$$2\ Ca\ SO_4 + H_2O.$$

It is interesting to note that the sulphate of lime ordinarily deposited in steam boilers possesses this same composition of two molecules of the anhydrous sulphate and one of water; and, moreover, this hydrate can be obtained by heating the ordinary gypsum with water to 150° in a sealed tube.

When plaster of Paris sets, or the partially dehydrated gypsum reunites with the water which was driven off in the baking, a perceptible amount of heat is produced, an elevation of temperature to the extent of 30° Centigrade being often observable. Here is a bell-jar in which there is a flask, which will serve as the bulb of an air thermometer, and now that the bell-jar has just been filled with freshly-mixed plaster of Paris, you will soon observe evidence of heat in the movement of the column of coloured liquid which is in the tube of the air thermometer. When plaster sets, an expansion of about one per cent. occurs, and this can be very well illustrated by filling a bottle with mixed plaster, corking it securely, and setting it on one side until it bursts from the internal pressure.

If the plaster has been burned at a higher temperature than that mentioned above, it will contain a greater or less proportion of anhydrous sulphate of calcium, and instead of setting rapidly when mixed to a thin cream with water, it will only become hard after a lapse of a considerable time, perhaps days or weeks; but in the end the ordinary hydrate $Ca\ SO_4 + 2H^2O$ is formed. Some important applications of a gypsum calcined at a high temperature will be considered in a few minutes.

The residual water of plaster of Paris may be replaced by certain saline bodies, as, for example, alum, sulphate of potassium, or borax, these substances being generally added to the baked gypsum in the form of solution; after which it is subjected to a somewhat higher temperature than before—a temperature which would dead-burn ordinary plaster. These cements (Keene's, Martin's, and Keating's) set in a few hours, and ultimately become so hard as to be capable of receiving a high polish.

The various kinds of stucco consist essentially of plaster, to which slaked lime may have been added, a solution of size being used for mixing; these additions causing the material to set sufficiently slowly to enable the mixture to be worked in the pasty or dough form. Marble-dust, sand, brick-dust, and other materials may be added to stucco in order to modify its character when necessary.

The applications of plaster in its various forms are numerous and important. First, as regards the use of a high calcined plaster as a constructive material. Messrs. Dennett and Ingle manufacture a large quantity of plaster, which is burned in an open furnace, like ordinary lime; and they apply this principally to the construction of fire-proof arches and floors; the plaster being made into concrete with fragments of brick or some similar aggregate. During the operation of calcination, a considerable, but somewhat variable, proportion of the sulphate of lime becomes decomposed, and the result is, that this high calcined plaster of Messrs. Dennett and Ingle contains a notable proportion of free lime and of oxy-sulphide of calcium Its value as a material for fire-proof construction depends, in a great measure, on these circumstances, as otherwise the plaster cement would fuse in a fierce fire; whereas experiment has proved that, in ordinary cases, the calcareous cement resists the action of fire even more perfectly than the brick aggregate. And, moreover, the concrete which has been exposed to fire has not so great a tendency to crumble under the subsequent influence of damp as is the case with ordinary Portland cement concrete, under similar circumstances. Numerous specimens, illustrative of Messrs. Dennett and Ingle's system of using their concrete for various fire-proofing purposes, are before you, and diagrams representing sections of floors and arches are fastened to the wall yonder. The concrete takes three or four days to set sufficiently for the removal of the centerings, and in the case of arches of six or seven feet span, a thickness of four inches is considered sufficient.

Another point in connection with this high calcined plaster as a fire-proofing material. Here are samples of wood and iron encased with it, the casing being in some cases but little over an inch thick; but these casings are found to protect wood or iron against the action of flame for a considerable time, and will probably prove of great value in the treatment of old buildings such as theatres.

The use of a selenitic or gypsum mortar is of advantage in many cases, the usual thing being a mixture of well-burned gypsum and lime; samples which are known to have been used over 350 years ago, being now in excellent condition and harder than the stones which are cemented. In Paris, various kinds of gypsum mortars are in general use, raw gypsum and other invert materials being often intermixed. It will be remembered that the plaster used in Paris contains free lime or carbonate of lime according to the degree of heat to which the raw stone has been subjected. The Hôtel de Plâtres in Paris affords good illustrations of the constructive uses to which plaster can be put, some of the blocks being over eighty years old.

Plaster of Paris makes admirable drying tiles for laboratory or manufacturing use; its porous structure rapidly removing and carrying away moisture from any wet and insoluble powder.

An illustration of the fineness of detail which can be moulded by plaster of Paris is well illustrated by these specimens of photo-engraving work executed by Mr. Dallas; plaster having been used in casting from the original phototypic model, after which the actual printing block is cast in the plaster-mould. The perfection with which plaster can mould fine details depends, to a considerable extent, on the circumstance that expansion takes place just as the plaster sets.

The operation of stereotyping affords a good illustration of an important use of plaster of Paris. Here is a form of type, the surface of which is slightly oiled. A border being placed round the edges of the form, you see that liquid plaster is poured on, the production of air bubbles on the surface of the type being prevented by dabbing through the liquid plaster with a camel's hair brush. In a few minutes it will be sufficiently set for removal from the type, but in order to expedite matters, a similar cast was prepared before the lecture, and it is now dry and hot in yonder gas oven. The hot cast is now placed face downwards in this flat metal pan, which is also hot; and after it has been properly secured, melted type metal is allowed to flow between it and the bottom of the pan. Sufficient has now been run in to thoroughly cover the cast, and this gas burner will keep it melted until the end of the lecture, after which it will be allowed to cool, when a cast, free from air bubbles or defects, is likely to be obtained.

Buns and tarts built up out of plaster and textile materials, and ingeniously painted to represent the real articles, form better materials for Christmas trees than for the usually accompanying feeds; and Mr. Barker will hand round a plate of them for your inspection. This kind of fraud on the unsuspecting lovers of confectionery has often one redeeming feature, as the imitation tart opens at the bottom, and reveals a store of sweetmeats. Those which Mr. Barker is handing round are, however, grosser frauds, as on opening the door at the bottom you will merely find a sarcastic inquiry as to your capability of eating a tart. Similar things built up of plaster and canvas are largely used as theatrical properties, and may represent rocks, animals, or other objects.

Messrs. Bellman and Ivey tell me that their extra superfine plaster, of which they have sent me some samples, is not only used in making the Scagliola for which they are so celebrated, but that many tons are sold each year to makers of sugar-almonds and other delicacies for children. You see, then, that plaster is used in fabricating the real as well as the imitation confectionery.

As regards the imitation marble or scagliola, which is so successfully manufactured by Messrs. Bellman and Ivey, you have only to look around to see some very fine specimens. This you may regard as Keene's cement, which has been coloured by suitable pigments; the various dough-like coloured plasters being incorporated so as to obtain the artistic and admirable results which you see before you. When thoroughly set, the articles are trued to shape, and polished. Messrs. Bellman and

Ivey tell me that in no case is the natural face of the cement hardened or prepared in any way, it being merely worked true and polished.

Something of a similar character can be made by mixing plaster to a pasty consistency, with a dilute solution of size, the required pigments being added. When the differently-coloured plasters have been incorporated, and the articles have become hard, the material is soaked with linseed oil, and polished with turpentine and wax. Fine plaster is often used for making crayons, which are to be used instead of chalk in writing on the black board, and Messrs. Lewis Wolff and Sons have lent me these specimens of plaster crayons, which they manufacture largely.

Plaster moulds are almost exclusively used for moulding the various articles of earthenware, and here is a mould with damp clay jug still in it; this having been kindly sent here by Mr. Emery, of Burslem.

Among other uses of plaster may be mentioned its use to separate the carbons in the Jablochkoff electric candle, for mounting various articles in sockets or on spindles, and for ensuring a steady bearing between surfaces of metal and wood as in the case of the iron plates which are bolted down to the woodwork of pianofortes for holding the pins.

The mineral tripolite, which consists principally of silica, lime, and protoxide of iron, yields a quick setting cement when slightly calcined, and may be used instead of plaster in many cases.

INDIAN SECTION.

Friday, January 13th, 1882; Lord ABERDARE, F.R.S., in the chair.

The CHAIRMAN, in opening the proceedings, referred to Sir Rutherford Alcock's competence to deal with the subject of the Opium Trade, he having lived for 20 years in China, where he had been compelled to study it in all its bearings, and to advise his Government upon it. He was aware that there was a very painful impression on the minds of some persons as to the morality of this trade, and that many believed that this country was not only importing on a large scale a pernicious drug into the most populous country of the world, but also compelling its introduction and use by force of arms. On the other hand, there was the fact that a very large revenue raised from one of the poorest populations in the world depended on this article, and that no disturbance of the financial condition of India, to the extent which the suppression of the opium trade would bring about, could be contemplated without very grave anxiety. They knew it was next to impossible for the acutest financier to discover any new source of taxation for India. At the same time he believed he was speaking the opinion, not only of the meeting, but of all England, that whatever might be the political difficulties connected with the finance of India, if it could be shown that the use of opium was to the great population of China the curse which it was reported to be, and that they were forcing its use on an unwilling people, no political necessity, however great, should ultimately alter the national policy on this subject. They could not allow their Government to be charged with corrupting a whole people for the sake of fostering one branch of commerce. He was sure that whatever might be the feelings of the meeting, Sir Rutherford Alcock would meet with a patient hearing.

The paper read was—

THE OPIUM TRADE.

BY SIR RUTHERFORD ALCOCK, K.C.B.

Great efforts are being made at the present time, under the auspices of a Society for the Suppression of the Opium Trade, to bring the pressure of public opinion to bear npon her Majesty's Government, and compel them to take decisive action for that object.

Two meetings have already taken place, one at the Mansion-house in October, under the presidency of the Lord Mayor, at which the Archbishop of Canterbury and Cardinal Manning were the chief speakers and supporters of the resolutions;—and another subsequently at Sheffield, with the Archbishop of York in the chair. An influential deputation to the Prime Minister, and an organised agitation to back it, are further calculated to excite considerable interest, and to rouse public attention to a subject of national importance.

I wish to speak with all respect of the high dignitaries, civil and clerical, who have given their names in aid of this movement. They are great authorities in their own spheres, and, as no one doubts their good faith, or good intentions, there is a natural reluctance to question the wisdom of their acts. Nevertheless, in such a discussion as they have actively promoted, concerning the Opium trade, its history, conditions, and influences, it is scarcely a disparagement to say that they cannot be supposed to have any great knowledge of the subject. It is one which cannot be mastered by a few hours' study, and when they give circulation, in their speeches, to exaggerations of the most mischievous and misleading character, it must be assumed that they speak from the briefs furnished them by others. But they cannot on that account be entirely acquitted of responsibility for the truth of the statements to which they lend their names.

And I may say here, that although most of the staple arguments and misleading opinions on opium and its disastrous effects come from the missionaries in China, whose good faith I do not question,—there is no stronger protest against exaggerated and sensational statements on record, than has been supplied by one of their number, the late Dr. Medhurst, of whom it has been truly said he was "one of the most able, experienced, and zealous missionaries in China." Opposed in principle to the opium trade in all its aspects, his statements will be readily accepted as unimpeachable evidence. The following remark occurs in an official paper forwarded to the Chief Superintendent of Trade at Hong Kong in 1855.[*] Alluding to a speech of an American missionary, who had visited England, and was reported to have told the British public "that the smokers of the contraband article have increased from eight to fifteen millions, yielding an annual death harvest of more than a million," and further characterising the traffic as "staining the British name in China with the deepest disgrace," Dr. Medhurst observes: "Such statements do great harm; they produce a fictitious and groundless excitement in the mind of the religious and philanthropic public at home, while they steel, against all reasonable and moderate representations, the minds of the political and mercantile body abroad. The estimate given has not even the semblance of truth; it is an outrageous exaggeration."[†]

And yet, in two memorials presented to Lord Clarendon by distinguished and justly respected noblemen, the Earls of Shaftesbury and Chichester, on the evils of the opium trade in 1855, these, and still more "outrageous exaggerations" appear with the authority of their names. Lord Shaftesbury officialises the estimate that 20,000,000 of Chinese are opium-smokers, and assumes that of this number $\frac{1}{10}$th (that is 2,000,000), die yearly, and states it as an "appalling fact." Appalling indeed! But what if it be a mere figment of the imagination, and absolutely devoid, as Dr. Medhurst says, of a semblance of truth? Mr. Hart's returns of all the opium imported into China even at this day, when the quantity has nearly doubled since 1855, show that the total annual amount of opium at present received from India does not exceed 100,000 piculs; and by a simple arithmetical calculation of the weight of prepared opium that quantity yields with an average consumption of *three mace* (one mace is equal to 58 grains), not more than a million of smokers can be furnished with their daily supply. How many or how few "victims" of this number die annually, and in consequence of their opium-smoking, Dr. Medhurst says, in dealing with the American missionary's statement of a million—and which Lord Shaftesbury, improving upon it, suggests may be two millions—that with all his "life long experience and knowledge" he would not even hazard a conjecture as to the "annual death harvest." Mr. Lockhart again, known throughout China as a zealous and able medical man, attached to Dr. Medhurst's mission, and the surgeon of the Missionary Hospital in Shanghai for many years, states in the same official paper: "It is impossible to say what is the number of such victims, either among the higher or lower classes." Which is strictly true, for there are no statistics to guide us. But even to reach the lower estimate of the American missionary of more than a million, evolved, apparently from his inner consciousness, like the German student's description of a camel which he had never seen,—we can see that it would involve the death of every individual of the whole number *now* supplied with Indian opium, who smoke much or little—a preposterous and incredible conclusion.

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[*] See Papers relating to the Opium Trade in China, 1842-1856, presented to the House of Lords.

[†] Dr. Medhurst comments strongly, in the same paper, on the American missionary's exaggeration in attributing all the sin and disgrace exclusively to the British, observing, "that missionaries know, or ought to have known, that American citizens are fully as much implicated in this affair in China, as the subjects of Great Britain. There are individual exceptions among the merchants of both nations, but on the whole, both English and American houses in China, trade in the drug, each to the full extent of their means." To the same effect is the following, in a despatch to Lord Clarendon, from the Chief Superintendent of Trade in China, in reply to Lord Shaftesbury's memorial (see Parliamentary Papers). "Lord Shaftesbury has been erroneously informed as to the trade in opium being confined to British subjects, or protected only by the British flag. It is a matter of general notoriety, that many of the principal American houses deal largely in opium, and that the flag of the United States is unfurled at the opium stations, over American ships, with American registers." To the same effect is an instance in the same despatch, from Messrs. Jardine, Mathison and Co.:—"Vessels of almost every nation trading in China being engaged in the traffic; while with but very few exceptions, the whole of the mercantile firms in the country (China) are interested in the trade." See also evidence of the participation of other countries as sources of supply. "Between 1814 and 1818, there was a progressive competition of foreign opium in the Eastern market, the rivals of the company being the traders in Malwa opium, and from independent native tribes in Central India, and in Turkey opium. The Turkey opium was principally conveyed to China direct from the Mediterranean, by Americans, and by British subjects, from Madeira; and although a very inferior and much adulterated drug, it proved a formidable rival." The opium from Malwa in 1830-31 considerably exceeded in quantity the whole amount imported from British India, being 12,631 chests, as against 7,477. This is only a matter of secondary importance, except as a question of accuracy, but on that head it is conclusive; because, if our action cannot be justified on other grounds, in does not much better the case of the British, to show their fellowship with others, although it takes from them the Pharisee's pleas when he thanked God he was not like "publicans and sinners, and fasted twice a week." For they neither fasted nor were total abstainers! But to make the plea of participation, such as it is, in the unpardonable offence of opium trading, there is abundant evidence that the much-wronged Chinese, at the very period of 1831, onward, while so busily employed in denouncing the foreign trader in this vile dirt, poisoning and destroying the people, were largely growing the same poison in their own province of Yun-nan, and driving a profitable trade with Burmah, conveyed by Chinese caravans annually to Ava, the capital, and there distributed; to the supposed destruction of the unhappy Burmese, their tributaries.

I think, after this short account of the kind of statements which pass current among religious classes and philanthropists in England, and have been circulated this thirty years past, under the high sanction and authority of such names as Lord Shaftesbury, and now,—with little modification in the figures, and none in the vehemence of the denunciations, with the authority of the Lord Mayor, the two Archbishops of the Church of England, and the Cardinal who represents here the Church of Rome, you will agree that it is time some one with knowledge of the facts should have the courage to enter his protest against the acceptance of statements of this character, and the inferences which would, if justifiable, affix an indelible stain on the nation. For many years it was my right and privilege, no less than my duty, to uphold and defend, not only the interests of this country, but the character and honour of the nation; and the habits of a life cannot be as easily discarded as a worn-out glove. I still feel the impulse strong upon me not to stand by in silence, while such attacks as I have described are being daily made, to the disparagement alike of the Government and the nation.

It certainly requires some determination to face the opposition that I may expect, and the certainty that among those whose opinions or convictions I must contravene, I shall be classed with the advocates of a protected opium trade, and opposed to all efforts for its limitation—or final abolition, if such a consummation were possible. This is, however, very far from the truth. I do not agree with the Society for the Suppression of the Opium Trade, either as to the practicability of the end, or the admissibility of the means proposed for effecting it; for reasons which I will presently state. But I have always desired to see the Indian Government freed from all direct participation in the culture, manufacture, and sale of the drug. And in 1869, when negociating the revision of our treaty, I did my best to induce both my own and the Chinese Government to come to an arrangement, the object of which was to gradually restrict the cultivation in both countries — to limit the consumption by diminishing the quantity of the produce and increasing the cost;—and ultimately, so far as might be possible or desirable, to wean the Chinese from its use. But I purposed to proceed gradually—to avoid all sudden or violent displacements of capital and industry, or deficiences in revenue, which are always, in my opinion, to be deprecated—and nowhere so emphatically as in India, and countries situated as China and India respectively are at this time. I did not succeed, for reasons into which I cannot enter here; but it was not from any want of effort on my part, or of earnestness in my desire to attain the end in view; and I did succeed in obtaining the assent of the Chinese Government, in principle, to the course I proposed.

I may be pardoned this much of personal explanation, because it is of the highest importance that, in the statements I have to offer, you should not be under any misconception either as to the object I have in view, or the feeling with which I approach the whole subject. I may add that, as I have never smoked an opium pipe, rarely indeed taken an opium pill as medicine, I cannot speak of the effects on the human system, except from observation of others, and such experience as is to be obtained by that process. But having passed more than twenty years of my life in the midst of a Chinese population — in large cities where opium smoking is most prevalent, from Canton to Pekin—a large field of observation has been open to me. And as I have never had any interest in the opium trade, apart from its moral, political, and commercial aspects, I may fairly claim to be heard on such a subject, as one who has had the best means of arriving at an impartial conclusion.

The Archbishop of York, at Sheffield, told the meeting that "the Christian nation of England has been in the past continually engaged in enforcing an unwilling nation to purchase great quantities of poison which it has grown for them, and have not scrupled to go to war even to enforce what I must call an unjust trade." And the Queen herself, as the Empress of India, is made responsible for the actual growing and selling of an enormous quantity of a drug for "poisoning the people, for destroying them physically and morally, and for corrupting a whole nation that is ready to protest against the corruption." Is this true—or any part of it true? That is the question which I wish to bring before you for judgment. And I may assume that what we all desire, is to arrive at the truth.

It is to be presumed his Grace of York could not mean that England has been continually engaged in forcing the Chinese people, either to purchase or to smoke opium which they neither required nor desired—although the language would bear this construction—because such a contention would be too absurd. This would be a feat that no nation has ever yet achieved. We must assume, therefore, that all the speaker could really mean, was that British ships and subjects brought into China waters an article for sale which Imperial edicts prohibited; and that the Chinese people chose of their own free will, notwithstanding such prohibition, and with or without the connivance of their own authorities, to purchase the opium so brought, and for a century continued to buy it in increasing quantities. When this is called an "enforced trade," it is clear it cannot apply to the people who were the purchasers, and if not, neither can it with any justice or consistency be applied to the sellers. It can only have even a remote reference to the Chinese Government, who, in some part of the period, issued edicts prohibiting the sale or purchase of the drug. But the binding nature of such edicts, and their value in such a question, must depend greatly on the will and the power to enforce obedience on their own subjects, at least, if not on foreigners trading in their ports. To promulgate laws which no one is expected to obey, which are habitually disregarded by the very authorities on which their execution depends, is not the act of a Government which foreigners can be held very strictly to obey. It is very doubtful policy for any governing power to make laws or to issue edicts they want either the will or the power to carry into execution. Open disregard and contempt of such laws are the necessary consequences, as we sometimes see nearer home; and such was the nature of all the Imperial edicts issued on the subject of the opium trade—from their first appearance, towards the end of last century, to the present day.

If a similar state of things existed in any European country, does any one doubt that the same results would follow, and a smuggler's vocation again become a flourishing and profitable one, as it was once in Great Britain, with little discredit attaching to it in the popular mind—and as it does now among the "contrabandistas" on the frontiers of Spain, from precisely similar causes? France is a wine-producing country, and her wine and brandy find a large and profitable market in England. A taste and a demand for such produce exists here; but what would be the result, if a reforming Chancellor of the Exchequer suddenly, in some spasm of national morality, or fiscal theory on some balance of trade or export of the precious metals in reference to the currency, were to raise the duties to a prohibitive rate, or declare all such products contraband—poisoning the people, demoralising and impoverishing the nation, and filling our prisons with criminals (all of which might be said with as much truth as of opium), with anathemas on the foreigner, in well rounded periods? There can be but one answer. A race of smugglers would speedily arise—native and foreign, and even with the most effective preventive service—contraband trade would be maintained in the teeth of the Government. And "all the Queen's ships, and all the Queen's men" would not avail to keep out the prohibited articles; whether they were wine and spirituous liquors for the men, or even lace, and gloves, or silks for the women. Should we ask France, or Spain, or Portugal, to come to our aid to stop this irregular trade by their subjects, carried on, *vi et armis*, by ruse—or by force, if the former did not suffice? We know very well what the answer would be. "Provide your own preventive service, we do not interfere, nor protect our smugglers." No doubt there would be violence and bloodshed, and abundance of ill-feeling between the parties engaged, and possibly the Governments concerned. But in what would such a state of things differ from that which prevailed on the Chinese waters for a century, and until the Chinese Government, grown wiser by experience of their own inability to provide any other remedy, legalised the importation of opium, at a reasonable duty, on the settlement of the tariff which took place after the second war, and *after* the signature of the Treaty of Tientsin? It has been alleged that this was the result of compulsion under the Treaty of Tientsin, but it is entirely untrue. Neither in that Treaty, nor in the later Convention, signed at Pekin, after all power of further resistance had been lost as shown by the fall of their capital, did Lord Elgin introduce any clause for the protection of the opium trade. The alteration made at Shanghai by the joint Commissioners, in placing it on the tariff at a fixed duty, was the spontaneous act of the Chinese for their own advantage, not for ours. And the power was still left them to levy any duties inland they pleased, and they have not failed to profit by it.

We shall be told that the difference consisted in this: that the British Government protected the trade in opium at the smuggling stations, if not ostensibly, yet certainly, by the fear of its superior power; and in confirmation, made war in 1840, to punish the Chinese Government for confiscating some 20,000 chests. And, secondly, that opium is a poison of so exceptional a nature, so seductive in its temptation, so firm in its grip, and deadly in its effects, that no Christian nation can be justified in producing or selling it, even if no force were employed.

The true answer to such allegations will best appear by the history of the trade, as shown in the table now before you, from the beginning to the present date, and it will show how slow and gradual was the early development of the trade, from the time when the Portuguese first brought their 200 chests from their own possessions at Goa, previous to 1767—increasing in subsequent years to 1,000—and the first appearance of the East India Company on the scene, in 1773, as importers of opium in small and quite insignificant quantities. Eight years later they could not dispose of a cargo of 1,600 chests; and it was not until 1790 that the annual import amounted to 4,054 chests, at which average it remained nearly stationary for the next 30 years, to 1820, never exceeding, in that lengthened period, 5,000 chests.

FOREIGN OPIUM TRADE.

First Period (uncertain length).

PORTUGUESE IMPORTATIONS.

	Chests.
Before 1767	200
Increasing in subsequent years to	1,000

Second Period (17 years).

BRITISH INDIAN TRADE.

Commenced in 1773 with small quantity of opium.

(In 1781 a cargo of 1,600 chests—found unsaleable and re-exported.)

Third Period (30 years).

In 1790 importation amounted to	4,054
And remained nearly stationary to 1820, never exceeding	5,000

Fourth Period (10 years).

Importation increased from 1820 to 1830 to	16,877

Fifth Period (10 years).

From 1830 to 1840, the date of the first war after Lin's seizure of 20,291 chests, the importations amounted to	20,619

Sixth Period (40 years).

From 1840 to 1880 in decennial periods.

From 1840 to 1850, increased to......	52,925
1860 piculs, when it became legalised as a legalised trade..	89,744
1870 piculs	95,043
1880 ,, ...	96,839

We have here to the end of the third period of half a century, during which the stake of the East India Company was so small, and the revenue, if any, so insignificant,[*] that it is morally certain, without any further demonstration, neither the Company nor the British Government would have risked a collision with the Chinese Government, or the stoppage of the tea trade, which was the chief interest of the company up to this date, as it was their chief care. What prevented the Chinese Government, during the whole period, adopting effective measures for stopping this opium trade? It was driven by their officials to a distance of 50 miles from Canton in the outer waters off the island of Lintin, where depôt ships were allowed to lie, for the most part without molestation? The fear of the power of Great Britain, we are told. We shall see shortly in what respect this power was held, and what was their estimate of its effective existence both by their official utterances and by their acts.

The trade in this latter period between the depôt at Lintin and Canton, was chiefly carried on by boats, paying regular fees or bribes to the Canton Custom-house and other authorities. Even as late as 1837-8, and during the eighteen months preceding Lin's raid on the British factory for the surrender of 20,000 chests, it has been confidently stated, that the trade was carried on chiefly in four boats, under the Viceroy's authority, which paid regulated fees to the Custom-house and military stations. What is to be said of imperial edicts thus treated with contempt by the Emperor's own executive officers? The first of these edicts prohibiting the trade, communicated to the Council of the East India Company, at Canton, in 1800, took much more effect on them than on the Chinese. Anxious chiefly for their profitable monopoly of the tea trade, they prohibited their own, the "country" ships, from that date, bringing opium to China; and, unlike the Emperor of China's edicts—their order was obeyed.

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[*] Under a million sterling in 1832.

Whatever may have been the motive or true cause, about which there hangs considerable doubt, it is certain that neither in the edicts of 1800, nor as late as 1832-4, when several Imperial edicts were issued against the introduction of opium from abroad, no reference whatever is made to the moral ground of prohibition, so ostentatiously paraded in later issues, and notably in Li-hung-chang's letter to the Anglo Opium Society last July. The reasons exclusively put forward in the first of these edicts, in 1793, were that—"It wasted the time and property of the people of the Innerland, leading them to exchange their silver and commodities for the 'vile dirt' of the foreigner." And as late as 1836, when memorials were presented to the Emperor, showing the connection of the opium trade with the exportation of sycee, they generally regarded the question in a political and financial character, rather than a moral light; and certainly, in several edicts issued between 1836 and 1839, when Lin made his grand coup, there is little, if any, reference to the evils of opium smoking, but very clear language as to the exportation of bullion. When we reflect that this "vile dirt," as I will presently show, was being extensively cultivated in the provinces of China, and largely consumed by his own subjects, we may be permitted to question whether the balance of trade turned by the large importation of opium, and the leakage of the sycee silver, so emphatically and angrily pointed to in after years, was not the leading motive for the prohibition of the foreign drug. We have it on authority, that, "From the commencement of commercial intercourse down to 1828-29, the balance of trade had always been in favour of the Chinese, and great quantities of bullion accumulated in China. Since that date, the balance of trade had been in the opposite direction, and bullion began to flow out of China. As silver became more scarce, it naturally rose in value, and the copper currency of the realm (and this only one) already depreciated by means of over-issues, and the mixture of foreign coin, of an inferior standard appeared to suffer depreciation when compared with its nominal equivalent in sycee; and the effects of this change fell heavily upon a large and important class of government officers, and ultimately upon the revenue itself. Memorials were presented to the Emperor on the subject, and the export of sycee was prohibited."

When it is said, as Dr. Wells Williams writes in his "Middle Kingdom"—notwithstanding the constant and open connivance of the local authorities at Canton for a century in an opium trade, in defiance of Imperial edicts—that "there is not the least evidence to show that the Court of Peking was not sincere in its desire to suppress the trade, from the first edict in 1800, till the war broke out in 1840"—one would like to know how such sincerity in an eastern autocrat, with arbitrary power like the Emperor of China, can be reconciled by Dr. Williams, or any other supporters of this view, with the notorious fact of the cultivation of the poppy largely in the provinces, as proved by memorials of Chinese censors in 1830-6? One of these, in 1830, represented to the Throne that the poppy was grown over "one-half of Che-kiang;" while one Nai-Tsi, another censor, strongly urged the policy of legalising the trade in opium on that ground, among others; and a third, in 1836, Cho-Tsun, stated that "the annual produce of opium in his native province of Yun-nan could not be less than several thousand piculs."

Lin's thoroughly Asiatic and barbaric mode of dealing with foreigners, was the real cause of the first war with China, commonly designated the "Opium war." If the occasion for Chinese violence had been cotton, or any other article of trade, war would no less certainly have followed. The object of the war was incidentally, no doubt, to compel the Chinese to refund the value of the property seized by processes in violation of all the usages and principles of international law. But it had other and wider aims, and mainly that of putting an end to a state of things utterly intolerable, and of commercial relations solely governed by the caprice and arbitrary will of an irresponsible Asiatic Ruler and his Satraps, who acknowledged no reciprocal obligations, and no rights on the part of foreign powers or their subjects. And this it accomplished, to the great benefit, not of

China and Great Britain only, but of the whole comity of civilised States.

Relations so strained, from indefensible acts on the part of an Asiatic autocrat, could not continue indefinitely, and must, sooner or later, have ended in one of two ways—by a total cessation of all trade and intercourse, or a treaty only to be obtained by war, and as the price of a victory over Chinese exclusivism, and pretensions to suzerainty over the rest of the world. War may be a hard master, but China would learn of no other. Twice in the course of the preceding fifty years England had sought, by a formal embassy to Peking, to effect this end by peaceable means—by Lord Macartney's mission in 1793, and Lord Amherst's in 1816, and each time unavailingly. In both cases the British mission was ostentatiously paraded before the Chinese population, *en route* from the coast, as tribute bearers; and in Lord Amherst's person the mission was treated with great indignity, because he refused to perform the kotow, and prostrate himself or do obeisance to the Emperor as Chinese Suzerain.

Again, when the East India Company's monopoly of the China trade was cancelled in 1834, another effort was made, by the appointment of Lord Napier as a Chief Commissioner, to enter into communication with the authorities at Canton, for the regulation of all matters connected with the British trade and interests upon a rational footing; and indignities were heaped upon the King's representative, and all communication with the Viceroy indignantly refused, unless in the form of a petition sent through the Hong merchants! Neither the measures taken at that time by Lord Napier under the instructions of his Government, nor those instructions were very wisely or judiciously conceived, any more than were the steps taken by his successor, Captain Elliot. But still the same spirit of arrogance and violence which dictated the treatment Lord Napier received at the hands of the Viceroy, and, later on, his successor—until it culminated in Commissioner Lin's sequestration of the foreign commodity—could not have failed to bring on a rupture and reprisals, as the only remedy for unbridled violence and misrule. The opium trade was only one of many causes—and not the chief of these—even though, as matters fell out, it stood in the forefront of the motives for Chinese violence.

The state of our relations, and all our intercourse, social, political, and commercial, during the whole period of the East India Company's trade, under the committee at Canton, which terminated by the abolition of their monopoly in 1834, is very truly and tersely described by the latest of their representatives, Sir John Davis, afterwards the Chief Superintendent of Trade and Minister Plenipotentiary in China. After long experience, and with all the advantage of a knowledge of the Chinese language, a most rare accomplishment fifty years ago, he writes, referring to the grievances suffered by our trade as far back as 1747, and which continued with little alteration for the better, nearly a century later, "The principal points were the delay in unloading the ships, the plunder of goods on the river; the *affiches* annually put up by the Government, accusing the foreigners of terrible crimes, and intended to expose them to the contempt of the populace; the extortions, under false pretexts of the inferior officers, and the difficulty of access to the mandarins."

It is remarkable how persistently, for a hundred years, the Chinese continued the same vexatious course, and identical modes of harassing and insulting the foreign traders, even to the posting of offensive placards, the sole object of which was to hold all foreigners indiscriminately up to contempt, and excite the hatred of the people—to serve which purpose no slander was too gross to blacken and vilify them. Long after regular and official intercourse had been established by treaties, the same odious practices continued, leading to outrages and massacres of foreigners, as I shall have to show.

Up to this period of 1840, where is the evidence of force on the part of the British or any other Foreign power to sustain the opium trade? Or how is it possible to argue that the Emperor and his authorities at Canton, to which most distant part of his empire all foreigners were compelled to confine their trade and intercourse with his subjects—were not free agents, or, that they had any fear of a foreign power? The whole history of our relations with China, up to the outbreak of the war, is one continuous refutation of such an assumption. In their unbounded arrogance in dealing with all foreigners, they showed such absolute faith in their own power, and such depth of ignorance as to the relative strength of foreign states, that any idea of equality of rights of an international character, cannot possibly have found a place in their minds. All their language and acts bore this out, too plainly to admit of dispute. Yet, lest there should seem any trace of exaggeration or inaccuracy in this statement, let me give you two or three proofs, in addition to those already cited.

The fundamental maxim of Chinese intercourse with foreigners, as Sir John Davis tells us, has been accurately translated by Premare, and is quite sufficient to explain their conduct:—"The barbarians are like beasts, and not to be ruled on the same principles as citizens. Were any one to attempt controlling them by the great maxims of reason, it would tend to nothing but confusion. The ancient kings well understood this, and accordingly ruled barbarians by misrule. Therefore, to rule barbarians by misrule is the true and the best way of ruling them."

With such rules of international intercourse, we need not be surprised that Lord Napier called the Viceroy of the province a "presumptuous savage;" while he in turn designated the British representative as a "Barbarian Eye"—in other words, a mere overseer or supercargo, whose business was to look after British ships and trade, and reverently obey the orders transmitted to him through the Hong merchants, not presuming to hold any direct communication with high officials.

There is of course much to be said to account for this habitual arrogance and pretension of superiority, if this were the time or place for a general history of our relations with China. It might be possible to show that both the Viceroy and Lord Napier were right from their own point of view, and both nearly equally ignorant of the real claims of each to more respectful treatment. But all I have to do here is to show, by a few facts, how profound and absolute was the ignorance of the Chinese officials of the outer world and the people they were dealing with in so summary a fashion. Abbé Huc, in his interesting book on China, gives many amusing examples of their grotesque ignorance. He says the Greeks fixed the abode of their monsters and ephemeral creatures in the East; and the Chinese have returned the compliment by placing theirs in the West, beyond the great seas. "There dwell their dog-men, and nations with ears long enough to trail on the ground as they walk. There is the kingdom of women, where they are regarded as superior and men inferior to them. From the King down to the people, all are subject to the authority of their wives." (Perhaps that may not be wholly untrue, and will not be so when the rights of women are fully established). "In the West also are the people with a hole right through them at the breast, the mandarins of which people, when they go out, merely pass a stick through this hole, and have themselves thus carried between two domestics, or chair-bearers." Of the English as a nation, they were accustomed to speak as an amphibious people, who lived on the water, and were very fierce, but quite incapable of fighting on shore. Nor was this ignorance confined to the uneducated, or the millions away from the coast and the seat of war, who had no opportunity of coming in contact with us. Mr. Meadows, the late consul at Newchwang, in his Notes on China, written at Canton after the signing of the Treaty of Nanking, in 1843, effectually disposes of this idea, by showing what the Cantonese, with whom there had been intercourse for more than two centuries, thought about us and our ways. Even after a war so disastrous to them, in which defeat was the invariable result of any attempt at resistance by land or sea, on the part of their own forces, the people in and about Canton, he tells us—"now confidently believe that although we beat the regular soldiers during the war, their own volunteer corps could expel us from the country; and only look upon the war as a rebellious irruption of a tribe of barbarians, who, secure in their strong ships, attacked and took some places along the coast, and an important point on the grand canal, and then constrained the Emperor to make them some concessions." While in more familiar matters, daily under their observation, the same incapability of understanding even what they saw was constantly manifested. Foreigners, long forbidden to enter the city of Canton, or walk beyond the narrow limits of the factory grounds, naturally took such exercise as was in their power, by pacing up and down the garden walks in front of the factory, which was enclosed with iron railings, to prevent intrusion. Here, day by day, idle and curious natives habitually watched the proceedings, much as country visitors at the Zoological watch the wild animals, and being quite unable from their own experience to conceive that these foreigners were doing, what the lowest Chinese coolie never does, walking for pleasure or exercise and without an apparent object, came to the conclusion that the foreigner, in his inability to use a *Swanpan* or *Abacus*, reckons up his accounts in this way, or that it is a religious observance; and the common answer to any inquiry made of one thus engaged, is, that the foreigner is walking his "thousand steps." It is only by recalling these facts, that we can understand their assumptions of superiority, and high-handed acts of spoliation or contempt—and how they lightly risked another war, rather than open the gates of Canton to the resident foreigners in daily intercourse with them after the first. As in the previous time, they would only permit a temporary residence to the East India Company's Committee in the factory outside the city walls, during certain months in the year, and peremptorily prohibited their wives, or any female relatives, living within their precincts. We need not be surprised, after this, to hear that to this day, whatever may be the admitted merit of our progress in science, or intellectual achievements—in point of morality, and the higher civilisation, we are considered very much their inferiors. How can a foreigner, who does not know, and cannot even read, the works of Confucius, lay any claim to respect or consideration as a man of culture? They believe, as Mr. Meadows observed, "that we had, it is true, the power to do some great and extraordinary things, but so have the elephants and other wild animals the Chinaman occasionally sees and hears of; in his eyes, therefore, we are all barbarians; without regular government, untutored, coarse, and wild."

How, then, can a nation with these ideas, and in total ignorance of the relative power of other states, be said to have a trade *forced* upon them against their will? At this time, 1840, such a possibility could not have found entrance into their minds. Nor, indeed, did it penetrate very far, even after the Treaty of Nankin. At that date, however, and from that period onward, force no doubt did come into play. That treaty was dictated by us, and its acceptance—however unpalatable the stipulations it contained, was the price of peace. Then was the time, if we were so disposed, for imposing upon them by force the opium trade, and its admission among the articles in the tariff at a fixed duty. But where is such a clause to be found? The whole treaty may be searched through, and not a word is to be found referring to the subject, or to opium in any way, with the exception of the 4th article, which simply specifies the sum the Emperor of China is required to pay "as the value of the opium which was delivered up at Canton in the month of March, 1839, as a ransom for the lives of her Britannic Majesty's superintendent and subjects, who had been imprisoned and threatened with death by the Chinese high officer." The same remark applies to the Supplementary treaty, signed a year later, in October 1843, containing all the trade regulations. Opium is not included in the tariff of articles which might be legally imported. Neither may it be assumed that the subject was overlooked. The Chinese and English negociators had it under consideration, as may be seen in the correspondence laid before Parliament in relation to the treaty. Both at that time, and subsequently, the matter was discussed between Sir Henry Pottinger and Keying, and later still with Sir John Davis. There was even a question of legalising the trade, on guarantee of a revenue of 3,000,000 of taels, which was declined on our part. It is quite true that the legalisation of opium was more than once urged by the British negociator, with a view to prevent all the discredit and disorder attaching to a contraband trade, and affecting the character and interests of both nations, but the Chinese chiefly, but no pressure was brought to bear on the Chinese Commissioners to effect it. And it was mutually agreed, and publicly proclaimed—that a perfect understanding having been arrived at between the Imperial Commissioner and the British Plenipotentiary—"On the subject of opium the British and Chinese Governments shall adopt their own rules and regulations respectively with respect to their own subjects." It was thus left open to the Chinese Government to treat it in the same manner as any other unenumerated article, and, if imported, to adopt whatever measures they pleased with their own subjects to prevent its sale or transit to the interior. If tacitly they declined to interfere with store or depôt ships in the outer anchorages known to contain opium, it is vain to contend that they were under compulsion in adopting this course.

And so from 1843 to 1856, as we see in the diagram, the opium trade went on largely increasing but unmolested. In 1856, a rupture was again brought on in October of that year, by a Chinese posse of officials and soldiers in a war-boat, suddenly boarding the lorcha *Arrow*, while lying, with her colours flying, in the river near Canton, and pinioning and carrying away the whole of her crew, after hauling down the English ensign. The alleged reason for this outrage was, that the vessel had a man on board said to be implicated in a piracy that took place two days previously. It has been asserted that this was another case of opium—but it was nothing of the kind. It afforded another occasion, however, for demonstrating how little fear the provincial authorities had of the employment of superior force by the British Government. And the second war that ensued afforded another occasion for the exercise of such force, to impose the recognition of the opium trade, if they saw fit to do so. The treaty was signed at Tientsin, however, without any reference to opium. Although in a remarkable, and in many respects a very sensible and practical memorial to the Emperor, published in the *Peking Gazette*, of January 4, 1853, a Censor, named Woo-ting-Poo, referring to the opium trade, had strongly advocated its legalisation as a source of revenue, and he alludes to the native opium produced in the west and south-west of China without any censure. He only says that the culture does not interfere with the rice crop, the one being grown in the winter and the other in the summer, and thus both contribute to obtaining the utmost profit from the soil, if both are legalised. Not that the memorialist is actuated by any friendly feeling to the English barbarians. He dislikes us, or at least feels under the necessity of ministering to the prejudices of those who do, and says, "from Peking and Canton officials and gentry, he has learned that "England is merely a poor anthill in the ocean; but we get rich by selling opium—wealth gave us power; this we used to seize on all the minor countries, particularly the opium-producing territories, and hence our stupid arrogance." And after recommending the levy of a duty as the best mode of enriching China and impoverishing England, he concludes by observing that, as the production of native opium increases, the importation of ours will diminish, and ultimately cease altogether. And that, with the exception of opium, as we have no produce of importance, our sources of wealth will be dried up, while those of China became more abundant. But that he by no means indulges the hope himself, nor holds it out to others, that the cultivation of the native poppy will cease, is very clearly shown. On the contrary, he tells the Emperor, "If the use of opium could be radically and completely stopped, that would be best; but the severest enactments against it have proved unavailing. A new policy is therefore to be adopted, suited to an altered state of things. "The holy men (Confucius, &c.), themselves," he adds, "did not attempt to stop the forced course of events. *Tobacco and spiritous liquors, prohibited by he Ming Dynasty, now yield a large revenue*; and if it be argued that opium renders the eaters incapable of business, and induces disease, the memoralist has to reply that there is nothing in the world but what proves injurious in excess. The same may be said of the wind and rain; and in eating and drinking, and other habits, it is self-control that will obviate the baneful effect." Although Chinese ignorance of foreign States makes this intelligent officer talk ludicrous nonsense about others, I think you will all agree that it would be difficult to take a more rational and sensible view of the question now before us.

Lin's proceedings at Canton serve more conclusively to prove the truth of my statement, that they themselves never doubted their right and their power to do whatever seemed good in their own eyes, where foreigners were alone concerned. The best informed Chinese, from the Emperor in his palace to the lowest officers in his service, looked upon all foreigners without distinction as barbarians; they never spoke of them, or wrote, except by the characters, *I*, signifying barbarian from uncivilised regions; or *Kweitze*, devil. *Fan-kwei*, 'foreign devil,' was the title by which I was greeted by all on arriving at the Consular Port of Foo-chow in 1845; and during the 18 months I resided there, it was the only one familiar to children and grown-up people alike. To all Chinese officials and people, we were looked upon, in the period I refer to and much later, as the subjects of some tributary power, having no rights, and only permitted by the all-embracing condescension and benevolence of the "Son of Heaven" and Suzerain to trade, under such conditions as it might please him and his provincial authorities to grant, and so long only as the orders transmitted were reverently obeyed and received with due humility. It never entered into their imaginations that any serious opposition could be offered.

Although it must be abundantly proved, by the evidence already given, that all the prohibitions, Imperial and local, issued against the opium trade on the coast and at Canton, were rendered nugatory by the virtual permission and open connivance of all the local authorities, not dictated by any fear of resistance, or the exercise of force by a foreign power, but in furtherance of their own views and interests. It was necessary also to show, in respect to the course adopted in the interior by the Emperor and his officials, in permitting and even encouraging the culture of the poppy over whole provinces, that whatever reason may be assigned for this policy, it is impossible to accept the moral ground, ostensibly assigned in all the Imperial edicts, viz.:—anxiety for the welfare of the people. If the Emperor and his ministers believed that the nation was being ruined, and their lives destroyed by the consumption of this poisonous drug, why did they allow its culture in provinces removed from foreign contact or contamination? Equally impossible is it to imagine that the fear of force from without could play any part in the Imperial Council. If they tolerated the continuance of a foreign trade under protest as forced upon them, they should, at least, to preserve any shred or semblance of consistency, have interdicted the open culture of hundreds of square miles of poppy fields, throughout nine of the great provinces most remote from foreign aggression or inflnence of any kind. We know it has been said by themselves some times, and more frequently by the advocates in this country of a total suppression, that the mere fact of their inabilty to keep foreign opium out of the Empire paralysed their power with their own subjects to prevent their growing it for cheaper consumption. And that, as a question of finance and political economy, if millions were—owing to the continued lawlessness of foreigners and perverted taste in their own subjects—to be spent and wasted, it would be better for the country, and a diminution of the evil, that the Sycee should remain in the Empire, instead of being drained out of it to fill the coffers of barbarians.

I am content to leave the appreciation of both these feeble pleas of justification to the common sense of those who are here, and will not waste time in arguments to prove their fatuity. Nor will I go into details and proofs, which are so abundant as to place the fact of such cultivation, even under Imperial sanction, beyond question, as this part of the subject has been already fully dealt with in my article in the *Nineteenth Century*.

The map on the wall and the accompanying figures will show that, out of the eighteen provinces of China proper, nine, or one-half lying to the west, and furthest from the seaboard, here coloured red, comprising an area of 971,282 square miles, and with an estimated population of 179,913,968, are largely under native poppy culture, and wholly supply their own population. There is a superfluity of evidence, from independent witnesses, in every sense trustworthy, *that no Indian opium competes, or has entered into consumption in all this vast region*, but some considerable portion of the produce is sent into the eastern provinces, on the other side, chiefly for admixture with the Indian, and to cheapen it. This native produce, being sold at half the price of the Indian, is further favoured a large differential duty upon the Indian drug. What the extent of the produce may be, no precise information can be obtained. Mr. Hart confessedly only makes a guess, and places it at 100,000 piculs—the same quantity as that imported into the Treaty Port provinces from abroad. But all his official informants admit they can place no reliance upon any native accounts on such a subject. The Chinese authorities themselves, probably, do not know, and are content to tax the fields, and whatever produce they find on sale, or in transit from one province or town to another. But that they do tax and raise a large revenue upon all the native opium they can trace, and *under imperial sanction and legal licence*, is quite certain. Thus, while we know with certainty the number of opium smokers that can be supplied by Indian opium—that is to say the maximum number it would furnish with an average daily quantity—we cannot know, even approximately, the number of smokers of native-grown opium. But whatever the proportion or the number—how is the foreigner responsible? The Indian drug is absolutely

AREA AND POPULATION OF PROVINCES SUPPLIED WITH NATIVE AND FOREIGN OPIUM.

Nine Provinces, chiefly supplied from India.	Area in English square miles.	Population.
Chili	58,949	28,114,023
Shan-tung	65,104	28,958,764
Shansi	55,268	27,260,281
Honan	65,104	23,037,171
Kiang-si	92,661	37,843,501
Ngan-hui		34,168,059
Kiang-si	72,176	30,426,999
Shensi	154,008	10,207,256
Kansu		15,193,135
Total	563,270	235,209,189

Nine Provinces, with native culture.	Area in English square miles.	Population.
Yun-nan	109,869	5,561,320
Sz-chuen	166,800	21,435,678
Kwang-si	78,250	7,313,895
Kwan-tung	79,456	19,147,030
Kwei-chon	64,554	5,288,219
Hu-nan	381,724	18,652,508
Hu-pih		37,370,097
Cheh-kiang	39,150	26,256,784
Tuh-kien	53,480	38,888,432
Total	971,283	179,913,963
Grand total	1,534,553	415,123,152

unknown in these province, we are assured by merchants and travellers alike. The poppy, there is reason to believe, is indigenous in China. It grows so extensively over the breadth of Asia, that it is difficult to fix its original habitat. It is certain that no foreign agency first introduced opium to the knowledge of the Chinese. The seeds of the poppy are said to have been used from time immemorial in the preparation of cakes and confections. But, be this as it may, their own authors prove incontestably, that it was known and in common use, though to what extent cannot be ascertained, before any foreign trade began. In the Chinese Herbal, compiled more than two centuries ago, both the plant and its inspissated juice are described, together with the mode of collecting it. Again, in the "General History of the Southern Province of Yunnan," which was revised and republished in 1736, opium is noticed as a common produce. It is beyond all doubt that the use of opium has been general amongst Asiatics, as a stimulant and narcotic, from a time unknown, and consumed, in one form or another, much as wine, beer, and spirits are consumed all over Europe. Smoking would seem to be the least injurious mode of imbibing its narcotic properties. I stated in my recent article that Sir John Barrow mentions, in his account of Lord Macartney's Mission in 1792, the prevalent use of the drug by officials and others within the upper ranks of society. In the fourth edition, of 1804, page 152, the following passage occurs:—"The upper ranks indulge at home in the use of opium. Great quantities of this intoxicating drug are smuggled into the country, notwithstanding all the precautions taken by the Government to prohibit the importation of it." I am accused of having said in my article that "there was a large and unrestrained growth of the poppy in China *before the Foreign trade existed;*" but I never said anything of the kind. How much or how little was grown in the last century there is no means of knowing. And as to the relative proportion now, or within the last fifty years which chiefly concerns us, of the native produce and the foreign importation, I only quoted the reports of competent authorities as to what they and others had seen, and their estimate of the probable proportion of the native growth being greatly in excess of the foreign supply in late years. Even as far back as 1847, within four years of the war occasioned by the furious zeal of Lin to confiscate and utterly destroy opium in the China seas, the cultivation of the poppy was known to be allowed. Of this I have already given many proofs on the authority of Chinese censors, but here is another of the same authorative character. Mr. Wade (now Sir Thomas), in a most instructive "Note on the Condition and Government of the Chinese Empire in 1849," chiefly derived from the *Peking Gazette*, while he was acting as Assistant Chinese Secretary to the British Plenipotentiary and Superintendent of Trade, gives the following information:—"From the testimony of some natives consulted, and from information officially collected at the ports, it is believed that the poppy is now cultivated in the nine provinces of Yun-nan, Sz-chewen, Kwang-si, Kwan-tung, Kwei-chan, Hu-nan, Hu-pils, Cheh-kiang and Fuh-keen. In the two last the opium sold is coarse, and reported to be more immediately pernicious to the constitution of the consumer than the foreign article. The crop in Kwan-tung, in 1847, was said to be from 8,000 to 10,000 piculs;" and adds, that the only accounts received from natives was given in such vague and "thousand myriad" phrases, that upon similar questions no reliance could be placed upon their evidence. But there could be no question as to there being a large native culture at that date.

In 1865, Mr. Watters, her Majesty's Consul at Ichang, reported "that all over Western China the conditions of poppy culture, as far as the officials are concerned, are those of perfect freedom, and even open encouragement." Thus, at the very time that the ministers were negociating with me for the prohibition of the British import of opium, on the moral ground that it was destructive to the people, and was strictly prohibited, both native culture and consumption in the provinces existed to an enormous amount, and paid taxes to the Government nominally prohibiting it one day, and sanctioning it the next by another Imperial rescript granting licenses.

Mr. Baber, another officer in her Majesty's Consular service, of the highest intelligence and ability, in 1877 traversed from North to South, nearly the whole of China, and especially the little-known Western Provinces to Talifu and Molmein, and he reported that he was "astounded at the extent of the poppy cultivation, both in Se-chuen and Yun-nan. In ascending the river (Yang-tze) wherever cultivation existed, we found numerous fields of poppy. Even the sandy banks were often planted with it down to the water's edge. But it was not until we began our land journey to Yun-nan that we fairly realised the enormous extent of its production. With some fear of being discredited—but, at the same time, with a consciousness that I am understating the proportions—I estimate that the poppy fields constitute a third of the whole province of Yun-nan." This province alone, as you may see, has an estimated area of 107,869 square miles. This information is more than confirmed by two independent witnesses, Messrs. Soltan and Stevenson, of the China Inland Mission, who traversed Yun-nan from Bhamo, in 1880-1, to the Yang-tze. M. Soltan says that in Yun-nan, "three-fourths of all the land under cultivation is occupied by the Emerald Poppy plant. It is largely cultivated in the valleys, but chiefly in the hills. The poppy pays better than any other crop, for not only does Yun-nan produce all the opium consumed in the province, but *opium forms the principal export, and is carried all over the empire of Burmah. No Indian opium reaches Upper Burmah*, the large amount consumed in that kingdom being entirely supplied from Yun-nan, and, it need not be added, *no Indian opium enters Yun-nan*." So much for Li Hung-Chang's solemn assurance, in July last, that his "Government will take effective measures to enforce the laws against the cultivation of the poppy in China, and otherwise check the use of opium; and I earnestly hope that your Society, and all right-minded men of your country, will support the efforts China is now making to escape from the thraldom of opium." I do not know how far the Society may "support the efforts China is now making"—but I think I can answer for a great many right-minded men of my country, after the information now given, declining altogether to be associated with either Li Hung-Chang or his Government in such efforts, either on moral or fiscal grounds. As to the latter, and the same great Minister's declaration, "once for all, that the single aim of his Government in taxing opium will be in the future, as it has always been in the past, to repress the traffic, never to gain revenue from such a source." I leave it to this ingenious coiner of specious phrases to reconcile this "single aim" with his last negociations with the British Minister to increase the import duties on opium, and better secure the Likin taxes; and his still later proposal to purchase of the Indian Government the monopoly of the present foreign trade in the drug for the avowed purpose of securing an increased revenue. To any ordinary understanding it would seem a very difficult undertaking to reconcile the two objects.

I leave these facts for the consideration of the Society for the Suppression of the Opium Trade, and believe any further evidence on this part of the subject entirely superfluous.

But, after all, this argument of force—were it better founded than it is—for the condemnation of our relations with China, in regard more especially to opium, must not be pushed too far. It is especially undesirable in the interest of missionaries. Force, no doubt, has been employed to bring about all existing conditions of intercourse, political and commercial. By no other means could the state of misrule and arbitrary exactions, under menace of injury to persons or property, already described as the only system of intercourse recognised by the Chinese, have been put an end to. Prevailing throughout the preceding 200 years, the outbreak in 1840 was the natural and inevitable outcome of the cumulative misdeeds of the Chinese Government and authorities. No doubt it is true, and may be freely acknowledged, that we "forced" ourselves—our trade (our opium as a part of it, if you will)—but also our missionaries, upon the Chinese Government and people. And of all these unwelcome intrusions, opposed as they were to the exclusive character and the national policy of this Eastern race, the most objectionable element in the whole was the missionary—the most productive of alarm and hostility, and the most persistently and bitterly opposed. We have been told quite recently, in regard to opium, that we should not consider what we Englishmen think about opium, but what the Chinese think about it. Would the Society in whose name this is urged, like this rule to be applied to opinions about Christianity and the Chinese Missionary? Can it be forgotten that the parting words of Prince Kung to the British Minister at Peking, twelve years ago, coupled two objects together, missionaries and opium, in his desire that China might be relieved of both? It is obvious that missionaries, of all other people, should be careful how they strain this argument of force as an objection to the policy which alone permits them, against the will of the Chinese Government, the authorities, and the people, to carry out their pious mission. It will not be disputed that we have imposed our missionaries upon the nation by treaty, as we have not imposed opium, and upheld them in the exercise of their functions against the will of the Rulers, and the unceasing and bitter hostility of officials, literati and gentry, even at the cost of a war, in the case of the French, and of armed intervention and the risk of war, on many occasions, on our own side. Yes, it is quite true there has been a Missionary war, as well as what is commonly, but not very truly, designated an "opium war." When the French forces joined the British in the war of 1858, it was to avenge the execution of M. Chadelaine, a French missionary, who was executed in 1856, at Si-lin, near the borders of Yun-nan, in the province of Kwang-si, by the mandarin in authority, after the most brutal treatment and long-protracted torture.* The French Government, immediately on receipt of the official accounts, announced its intention of obtaining ample reparation, by an expedition if necessary. We have heard much of the hostile influences traceable to opium and the opium trade, and especially the obstacles and prejudices it has created against their labours for the conversion of the people. But I can say truly, in my own experience, that during a quarter of a century spent in the far East—the heaviest responsibility I ever accepted, and one of the greatest perils encountered, was in defence of a missionary party, nearly murdered by some Shantung junk-men at Tsing-Poo, a town situated at some distance from Shanghai. In the course of my proceedings, I had to maintain for nearly a month a blockade of an Imperial fleet of Rice junks, whilst living myself, with my family, in the heart of a Chinese city, surrounded, beyond all chance of rescue or escape, by hostile authorities and a populace entirely under their control. And I may add generally, that no small part of the work entailed upon the Foreign Legations at Peking, the Consuls at the ports, and her Majesty's ships in the China seas, arises from missionary questions, and the duty of exacting reparation for injuries inflicted upon them by the populace or the authorities, wherever these operations for the conversion of the people extend. I don't think any better evidence can be required to show in how hostile a spirit they and their labours are regarded. Of this I am well assured, that if the Chinese Government and people were left to the free exercise of their own will, without any fear of consequences from the force which is known to uphold the treaties, that they would speedily, and by general consent, make a clean sweep of all foreigners — of ministers and consuls first perhaps, but of missionaries assuredly in the second place—missionaries of all denominations and nationalities—and the merchants last, even the traders in opium. Viewed, therefore, in whatever aspect we please—as a cause of political enmity, or an obstruction to missionary success—the opium trade must occupy a very subordinate place in any true estimate of the influences in operation, during the last forty years, to prejudice the minds of the Chinese, and keep up the spirit of opposition and hostility to the foreigner and all his works—hostility which has never been absent in all their intercourse with the European race from the beginning, now more than two centuries ago, to the present time. And if we may judge of the real cause and object of this enmity by the most authentic declarations of the people themselves, and the educated classes known as the "literati and gentry," and the officials, as well as the long series of outrages, murders, and massacres, all directed against the missionaries and their work, without discriminating between Romanist and Protestant, the enmity created by the foreign importation of opium sinks into insignificance, and will not bear comparison with the hatred felt and openly expressed for missionaries of every denomination and their doctrines. That I may not be charged with exaggeration, I will cite one or two of the most striking of these written expressions of feeling, perpetually recurring in placards posted up in the streets—for, as to the long list of cruel attacks on the person and property of the various missions in nearly every part of China where they have penetrated, these are too well-known to require much further evidence.

I hold in my hand the translation of a Chinese book, with the sinister title of a "A Death Blow to Corrupt Doctrines "—which in the title page is called "a plain statement of facts published by the gentry and people." The translators, missionaries themselves I believe, tell us in the preface that the book in the original came into the hands of the missionaries in Teng-chow, in the province of Shantung, in 1870, and that it was regarded—very justly, I think—"as of too much importance to be witheld from the foreign public, believing as we do, that it is a remarkably truthful representation of the animus of the ruling and literary classes of China towards foreigners. We believe also," they proceeded to say, "that it has been largely instrumental in giving rise to the vile and slanderous stories concerning foreign residents (missionaries ?) and native Christians which have recently spread through China; and that it sheds important light on the means by which the recent massacre at Tientsin was brought about. No mere description, however full, could possibly convey any adequate idea of its vileness and deadly animosity." They further add, "It may be said that the book is directed against the Roman Catholics, and that Protestant missionaries need not concern themselves with it." "It is a sufficient reply," the translators say, "that although its phraseology applies primarily to Roman Catholics, it has, in point of fact, been used and quoted against Protestant missionaries; not only so, but in the body of the book itself, Roman Catholics and Protestants are expressly declared to be the same; and it is explicitly stated that the distinction made between them, in the recent treaties, is a mere pretence or subterfuge devised for the purpose of avoiding the obloquy which the previous history of that religion has brought upon itself. It is furthermore notoriously the fact that the masses of the people know no distinction. They class all Europeans together, and their religion they regard as one." Practically, then, and in the intent of the author, the book is an attack on Christianity and Christian nations at large. It is, for the most part, a compilation from other works, and a portion of it was written against the Jesuits as long ago as the 17th century. "The author," we are further assured, "with great pains and no little research, has collected every false and slanderous charge within his reach, which would suit his purpose, and, without intimating that they have been disproved, reproduces and reiterates them in the ears of the present generation, with all the confidence of truth, and makes them the occasion of a fresh appeal to the people to rise against foreigners and exterminate them."

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* See correspondence respecting "Insults in China," presented to the House of Lords, 1857, p. 220-1.

Now this is a very remarkable fact, that in the year 1870, nearly thirty years after the Treaty was signed, and contact established with foreigners of all nations and their missionaries at five Treaty ports, amidst great populations, such a book should be published professedly by the "Gentry and People." And whatever may be the history of its authorship, we are told that it has undoubtedly been written by some one of first-class education and literary abilities, with extensive facilities for consulting public documents, and ransacking all that has ever been written in China against foreigners or Christianity. And the author, or parties interested in its publication and circulation, must hold no mean position, seeing that they can secure its distribution throughout the country by the "hands of the mandarins and their underlings." The book is generally attributed in China to Reng-yu-hien, an official in high office, and lately spoken of as a probable successor to a Viceroy at Nanking.

But whoever may have been the author, the translators state their conviction that it shows, in a vivid light, the real animus of the people, who have arrayed themselves against missionaries and foreigners alike, and seek to manufacture a public sentiment ready for any deeds of violence and blood. The book begins with an extract from the "Sacred Edict," suppressing, as the author asserts, "strange religions, for the purpose of exalting orthodox doctrine." This "Sacred Edict," we are told, in a note of the translator, "so-called because written by two of the canonised emperors of the present dynasty, is a kind of paternal address from the throne to the people, and is held in the greatest reverence by the Chinese." The first part was published by the Emperor Kanghi in 1676; and his son Yung-chen published, in 1724, an amplification: the two productions constitute what is called the Sacred Edict. The artful design of the author of the pamphlet is evidently to convince his readers that, to drive out foreigners and their religion, would be but carrying out the views of the most renowned emperors of the present dynasty, if not of Chinese history, —and certainly many passages in the introductory chapter go far to bear out this conclusion, that the religions of the West are not to be regarded as "Orthodox," or as teaching authorised doctrines; and, as for "unauthorised doctrines, which deceive the people, Chinese laws cannot tolerate them; and for false and corrupt teachers, the Government has fixed punishments." Chinese subjects are accordingly enjoined, with submissive reverence to the Imperial will, and in obedience to it, to "reject and oppose corrupt doctrines as you would robbers, conflagration, and flood. Indeed, the injury inflicted by flood, conflagration, and robbers extends only to the body, while that of corrupt doctrines extends to the mind." Then follows what the author of the pamphlet calls a collection of facts respecting the false religion of Tien-chu, by a a "man of Jao-chow, above all others distressed in heart." The religion of Tien-chu, as he explains, originated with Jesus—and is universally adopted by all Western nations, and Jesus he describes as an impostor, who his adherents falsely assert was endowed with divine gifts.

I am not going to shock my hearers by quoting any of the ribald, obscene, and atrocious calumnies with which this writer has filled his book, collated, he says, from "authorities consulted," of which he ostentatiously quotes a long list at the commencement. One of the mildest of the iniquities attributed to Christians is obtaining the eyes, brains, heart, and livers of children for some magical and occult purposes, and the performance of incantations to bewitch their victims for nefarious ends, by which means those who follow their instruction become their abject slaves.

When such vile calumnies as this book contains can be circulated among a whole people, with the connivance, if not the direct intervention, of the educated and ruling classes, we cannot be surprised at such a butchery as took place a little later at Tientsin, of which I have already spoken, as a true index to a prevailing tone of mind and opinion among the Chinese. This massacre of a whole mission, together with the French Consul, secretary, and other foreigners, is, in fact, a typical example of the outcome. It was the most daring and atrocious of all the series of outrages of which missionaries had been the victims since the Treaty of 1842, which stipulated for the free exercise of their religion, and tolerance for their converts. It was not a sudden outbreak of the populace, but a deliberate and planned attack. Some days before June 21, 1870, the British Consul wrote to the *Chargé d'Affaires* at Peking, Mr. Wade, to report a very unsatisfactory state of things at the port; and that for some time previously there had been threats from the Chinese that they would kill the foreigner, or drive him away from the port. "The last few days," he says," "the excitement has increased; the Chinese have declared their intention to burn the Roman Catholic cathedral, and the French consulate, and to kill all the foreigners." There was no ship of war of any nationality at the port, and the Consul expressed a well-founded anxiety—as the event only too plainly proved—for the safety of all in the Foreign Settlement. The authorities were appealed to, and, as usual, with no effect; and later in the day, the Consul had to report to Peking that "his worst fears had proved only too true," and that the Cathedral, French Consulate, and Sisters' Hospital were burned to the ground, that the French Consul had perished, with a Russian lady and her husband, and several of the sisters. When the details came to be known, however, the calamity was found to be much greater than at first reported. The deliberate and premeditated violence of the mob exceeded anything the imagination could have pictured in ferocity and brutality. Some days elapsed before what had taken place could with any accuracy be ascertained. It was not until the 24th, three days after the destruction of the cathedral, hospital, and consulate, that the floating bodies of the victims in the river revealed the full extent of the horrors perpetrated. On the 23rd, Mr. Lay, the acting consul, on information, went to the river-bank, where he found the remains of a Russian lady, just married to one of the Russian residents, and a few minutes later that of her husband, and close by another, a Chinese, one of the coolies, who was killed while carrying them through the city. The lady had her chemise tied round her head and was otherwise quite naked—her left arm was broken, and her body covered with wounds. Later, a third Russian was taken out of the river, and shortly after this, the body of the French Consul, although Chung Hou had assured Mr. Lay and his colleagues that Fontaines, the French Consul, was killed by his side, and that his body was in the Yamen. His body was fearfully mutilated, and he was naked except his feet. Still, later in the day the officials sent to say that they had picked up five bodies—French—which were sent to the consulate, and the Consul says, a more fearful spectacle he never saw—as may well be imagined. The first coffin contained a Mr. Thompson, who was on his way to Peking with his wife when the attack took place—he had been cruelly maltreated—and the second coffin contained his wife, having been killed, apparently, by a fearful gash at the back of the head. The next was the body of M. Simon, the French Secretary, and was so cut about that it was difficult to recognise the features. M. Chevries, the head of the Lazarist Mission, and the body of one of the Christian ordained priests, it is supposed, but utterly unrecognisable, close the dismal list, but not the death-roll. M. and Mdme. Chalmassoir, a French merchant and his wife, had also been killed, the first on coming out of his own door. His wife escaped down a small China street, and was taken into a small house and concealed by the women; but at night she dressed herself as a Chinese girl, and went back to her own house. Finding it deserted, she tried to return; but having forgotten the house, and knocked at the wrong door, and called out to open, the people heard her, knew she was foreign from her accent, and killed her. But the most painful part of this tragic story still remains to be told. Nine Sisters of Charity, who had devoted their lives to works of mercy at the hospital for sick and destitute children, found none from their assailants. They were all sacrificed under circumstances the most revolting. They were stripped and exposed to the brutal gaze of the rabble, and then stabbed, and their bodies flung into the fire blazing around them. I have given these hideous details, because it is only by such knowledge that the ferocity of a Chinese populace and the intensity of their hatred can be realised—or the cruel duplicity and supineness of all the authorities and Chinese officials, if not their active complicity, as in this case there was only too much reason to suspect. The cry raised to excite the mob was a repetition of the atrocious calumnies of the book just described—of kidnapping men and children to take out their eyes, for occult practices. It may seem incredible that such charges should find acceptance; but yet the scenes described at Warsaw, in a Christian country, on last Christmas Day, when the Jews were butchered quite as ruthlessly by a furious mob without any provocation, and on very similar charges and pretexts, is an exact counterpart. And as if to make the parallel more complete, the authorities showed the same disgraceful supineness, and allowed the Jews to be murdered and their homes to be wrecked, just as the homes of the Christians at Tientsin were, and in each case any honest effort on the part of the authorities and police would have effectually prevented or put a stop to such outrages. In Tientsin, the Chehien or magistrate, a few days before, when information was given of the impending danger, had actually—under pretence of calming the excitement of the people and disabusing their minds of unfounded suspicions against the mission, instilled into them by the evil-disposed—issued a proclamation confirming these suspicions, and treating the charges of kidnapping as having some real foundation, and evidently giving credence to the malevolent reports against the sisters. It is this duplicity of the authorities and officials generally in all matters affecting the foreigners, their lives and interests, which has been a constant element in all our relations and dealings with them. Proclamations with high sounding phrases enjoining respect for the laws—which to the people accustomed to such formal prohibitions meant nothing, or rather read between the lines—were interpreted to mean full license. As it was in this case, so in all others, of which a hundred might be cited, even since these disastrous wars might have proved the danger attending such bad faith—has been a constant quantity. The same double-dealing and insincerity has marked all their dealings with the opium trade, and with the natural result of encouraging an illicit trade with the foreigner, and simultaneously an extensive native culture of the poppy in the teeth of a perennial flood of denunciations and prohibitive edicts from the Emperor and local authorities. Sir John Bowring was perfectly justified, therefore, in replying to and refuting the monstrous allegations contained in Lord Shaftesbury's memorial to her Majesty's Secretary of State for Foreign Affairs;* and in alluding to the depravity of the public morals among the higher classes of the Chinese, not unfrequently referred to even in documents which appeared in the *Peking Gazette*—of the large consumption of opium in the Imperial Palace, and at that time of the licentious habits of the reigning sovereign, which had been the subject of official censure, Sir John says:—

> "I mention this (the above facts) because, contrary to all evidence, the moral sense in China, in high places, has been represented to be exceedingly sensitive with reference to a national vice which permeates through every grade of society, and, unhappily is not checked by a healthy state of public opinion; and while, in many of the provinces where the power of the Government is absolute, the growth of the poppy is permitted, and the manufacture of opium encouraged, the vehement language of some official documents may certainly be interpreted rather as a manifestation of ill-will against foreigners, and a repugnance to intercourse with 'barbarian nations,' than as evidence of a desire to preserve public virtue from taint, or the public health from injury. And it may well be doubted whether a declaration, on the part of the East India Company, that they were willing to stop the growth and the export of opium, would influence, in the slightest degree, the repulsive policy of China."

And as to the religious bearings of the opium, and the paralysation of missionary efforts consequent upon the trade, we shall all agree with Sir John when he says, in the same despatch—

> "When, however, it is said that the principal cause of the non-success of missionaries in China is the introduction of opium by professing Christians, and that the use of the drug greatly augments the difficulties which missionaries meet with in the cir-

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* See despatch No. 26, of Jan. 8th, 1856, in papers relating to the opium trade in China, 1842-56, presented to the House of Lords, by command, May 8th, 1857.

culation and reception of Christian doctrine, it might be reasonably asked whether the greater proportionate number of native-professing Christians are not really to be found in the districts where opium is most consumed? I venture to express an opinion that the small success of missionary efforts in China is traceable to other causes than the existence of the opium trade; but this is not the place for justifying such an opinion.

"It is true that, as in Great Britain there are numbers of most excellent and religious men who would, by the most stringent and active legislation, prohibit the manufacture and sale of all fermented and intoxicating liquors, whose fatal effects, if honestly pourtrayed, would present pictures infinitely more alarming and appalling than the use of opium exhibits in China; it is true that China is honoured by the appeals of eminent and eloquent individuals, who have earnestly declaimed and protested against the introduction, sale, and smoking of opium; but I must doubt the existence of that high moral sentiment against the use of opium which is represented as actuating the great unctionaries or the people in general."

It is a fact beyond question that the British Government have never claimed a right to introduce opium, prior to 1859, exercised any force to protect the Foreign trades in opium transactions, or disputed the right of the Chinese Government to make what laws they pleased to prohibit its importation.

But I repeat that, in view of the past history of all our relations with China, too much has been made of the use of force in placing our intercourse on a more stable and equitable basis. In no other way, and by no other means, could that end have been attained. Whether one nation is justified in forcing itself on another—their intercourse, their trade, and their religion, or any one of these—is a question of too large a scope to be discussed here. But assuming that such a right exists, and has in all ages and in every part of the world been enforced when there was the power to do so, then all past history shows that between the European and Asiatic races no treaty or conditions of permanent intercourse has ever been entered into, save by force. No Eastern potentate or people have ever welcomed the intrusion of strangers into their domains with pretensions of an international character. China has only followed the invariable rule of rejecting and resisting, to the extent of its power, the efforts of Great Britain to establish such relations. And after the rapid survey I have taken of the progress of trade and Treaty obligations, and how these latter have been disregarded by the Chinese authorities and people, I think it will be evident to all that we may well congratulate ourselves that we have "enforced" treaties on a civilised basis, and that there is known to be such a force in reserve to uphold them in their integrity, that not even an empire like China, with its vast resources, can with impunity violate their humanizing condition of international relations. What part opium may with any truth be supposed to play in this unpleasant and hostile spirit is not clear—there is little evidence to show that it has any. But of one thing I am entirely convinced, that none of these brutal and ferocious outrages and onslaughts, of which missionaries or still more helpless women have been the chief victims, have ever been perpetrated under its influence. The opium smoker is both passive and harmless while under its spell—those who commit deeds of violence are not of their number, though drinkers of samschoo may be, and usually are, leaders of tumult, brawlers, and habitual disturbers of the peace wherever they are found.

Turning now to the vital question on which, as regards opium, the morality of its consumption mainly turns, we have to ascertain whether there is anything in the chemical composition and physiological action of opium so exceptional in its nature, in the destructiveness of its allurements, the strength of its grip, or the enervating and demoralising power it exercises over its habitual consumers, that it cannot be classed with any other of the large and universally distributed products of the earth, possessed of stimulant and narcotic properties, in common use in different countries.

Because this is what is asserted of it; and this is how it is regarded by those who declare a nation to be covered with infamy who take any part in its production or sale. Unless it can be shown that it has this entirely *exceptional* character—is a poison pure and simple, the administration of which can be no benefit to man, and must be fatal as no other narcotic or stimulant in common use among all the nations of the earth—Christian and heathen, civilised and savage—those who advocate its total suppression as a national duty, and would apply a stigma on any nation producing it, must be content to let it be weighed in the balance with all the others.

Of the testimony of the missionaries, I may say at once that their graphic descriptions of the deplorable and irremediable effects of opium, as these have come under their notice, are no doubt accurate and trustworthy. But it is true, as any description of the frightful condition to which habitual dram and beer drinkers are reduced in every day's experience would be true, when *delirium tremens* is a constant liability, and imbecility with softening of the brain closes a longer or shorter life of intemperance. But unless all who habitually consume wine or malt and spirituous liquors were drunkards, and victims of an inevitable tendency to that end, which we who live among them know is not the case, it would not be true, as applied to the great mass of non-abstainers in the population. And although it must be admitted there is a very general consensus of opinion among the missionaries, even this is to be taken with many qualifications. Some among their number, and others working with them, medical practitioners in populous Chinese cities, in every way fitted by professional training and knowledge to arrive at a right conclusion, have not less emphatically recorded their dissent from the adverse conclusions of the missionaries, as applied to the great body of opium smokers; and this is the contention of the second class of observers, who have no motive for misrepresentation, are above suspicion of any wilful perversion of facts, and are unusually exempt, by their position and vocation, from class prejudices or foregone conclusions.

The evidence of the merchants may be supposed to be liable to bias, but cannot be overlooked. Some of the oldest residents, and members of the great firms, have borne witness to the perfect efficiency of their compradores, and others, to whom, in a long series of years, large sums of money and important business transactions were daily entrusted, although their habits of opium smoking were well known. We will take the missionaries first, selecting as their representatives those who, as medical officers, are most competent to speak professionally.

Dr. Hobson, long and honourably known in connection with the London Missionary Society, and zealously engaged in missionary work as the medical officer in charge of the hospital at Canton, in giving his opinion, says*:—

> "I must first premise that I place alcohol (the bane of Great Britain) and opium (the bane of China) in the same category, and on the same level, as to the general injurious influence upon society; what may be said against the latter may be said with equal truth against the former. I shall have opportunities, as I proceed with my letter, to remark the analogies and differences that subsist between them. It has been my painful experience to have been brought in contact with individuals indulging in both these unnatural stimulants.
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> "You will see from these observations that I do not, and cannot regard the use of opium by the Chinese as a matter of little consequence. I must pronounce it a great and growing evil, the alleviation or removal of which every true philanthropist must desire and rejoice to see. But as an act of justice to my country, to the East India Company, and British merchants, who have been so much abused at different times by the public press, both in England and America, I do not hesitate to affirm that many things said against the opium trade as 'facts,' are merely assertions and problematical theory.
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> "It is very common to hear Chinese acknowledge that they have smoked opium ten, twenty, or even thirty years. I have seen a few who have taken it forty years; and I have heard of one (probably an extreme case) who began taking opium when he was nineteen, and took it regularly for fifty-one years; he died lately at the advanced age of seventy years.
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> "Opium is probably more seductive and tenacious in its grasp than alcohol; and I should certainly affirm that it was not so frequently fatal to life, nor so fruitful of disease and crime, as is the case with intoxicating drinks in Great Britain."

Dr. Eatwell says: "Proofs are still wanting to show that the moderate use of opium produces more pernicious effects than the moderate use of spirituous liquors; while it is certain that the consequences of the abuse of the former are less appalling, in their effects upon the victims, and less disastrous to society, than the consequences of the abuse of the latter."

The Colonial Surgeon of Hong-Kong, in 1855, gave it in evidence, as the result of his experience, "that more disease and a greater mortality takes place from excess in drinking spirituous liquors, among the 600 foreign residents in Hong-Kong, than results from the use of the latter among 60,000 Chinese of the native population."

Dr. Myers, in the Medical Reports of the Inspectorate of Chinese Customs, for 1880, just issued, gives at considerable length the results of his experience, during ten years, while in charge of a hospital establishment for the Chinese, in Formosa, where 20,000 patients have been treated. During this period, he has closely investigated the effects of opium, under circumstances peculiarly favourable for observation, and putting aside the moral aspect of the question, he confines himself simply to the professional bearing of the subject, and claims to rank among those who can speak from an entirely impartial and disinterested point of view. The conclusion he comes to—from his experience in Formosa, where a great proportion of the Chinese are opium smokers, and in Chehkiang, where he practised before coming to Formosa, and the opium pipe is also in general requisition—is that the smokers generally, over China, may be divided into two classes. 1st. The minority, who, being either officials or well-to-do persons, can afford to give way to their passion, and indulge to excess. 2nd. The majority, consisting of persons who are obliged to work hard for a living, and among whom moderation is the rule. Here, as elsewhere, the grand prompter to excess is the co-existence of idleness; and those who, having no occupation, seek among the vices for relief from otherwise unbearable *ennui*. In other circumstances, case after case will be met, of men who have smoked regularly from 10 up to 20, or even 30 years, and who, as far as he can discover, show little or no signs of mental or physical degeneration. The average amount consumed by these is from one to two mace per diem.

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* See inclosure from Dr. Hobson to Sir J. Bowring, in despatch No. 26, Nov. 6, 1855, Parliamentary Papers above cited.

"Here, in Southern Formosa, there is a class of men, including the coolies, chair-bearers, and couriers, who daily do an amount of physical work that is remarkable in its extent. These have for years been in the habit of taking a certain quantity of opium during the day, seldom or never varying it; and they assert that by so doing they at least attain a greater degree of comfort in carrying on their labours, and, with but very rare exceptions, I must admit that I have failed to obtain evidence which would justify me in attributing any marked harm to their habit.

"Of course, among every class of men there are those to whom moderation is impossible, and who, in the gratification of their desires, will drag themselves and those dependent on them to the lowest misery. This we find one of the greatest evils connected with alcoholic intemperance; but I must say that my experience, both here and in other parts of China, would go to support the statement that the use of opium through the medium of a pipe does not, at least up to a certain point, so irresistibly and inherently tend to provoke excess as undoubtedly is very often the case with the stimulants commonly indulged in by foreigners.

"Were the seductive powers of opium so great and cumulatively overwhelming as has sometimes been asserted, I cannot but think that, among the class of which I am now speaking, dependent as most of them are for a livelihood on their exertions, we should have a very much greater number of instances of its disastrous effects on purse and person; but I do most conscientiously state that, although I have met with instances in which the effects were most marked and deplorable, still, when considered in numerical relation to the numbers who smoke opium, I have been struck with their paucity, and my preconceived prejudices with reference to the universally baneful effects of the drug have been severely shaken.

"As contrasted with the drunkard, the opium sot decidedly has the advantage—that is, as far as his bearing to his fellow-beings goes; for whereas one, under the influence of liquor, is noisy, quarrelsome, and often dangerous, the druggard (if I may for convenience coin a word) is at least quiet and orderly. That abuse of alcohol is a marked factor in the production of crime of the most heinous nature, all will admit; while, as far as I can learn, opium comparatively seldom leads to crime, and even then, this rarely, if ever, attains to higher dignity than petty theft."

Dr. Tanner, again, in his standard work on "Practice of Medicine," suggests, in the case of confirmed dipsomaniacs, the substitution of opium eating for wine bibbing as the lesser of the two evils.

Dr. Jamieson, in his Hankou Report, refers to the presence in opium of another active principle and alkaloid besides morphia—which is not narcotic — and is termed, not very happily, by chemists, narcotine, for it has nothing narcotic in it. It is a bitter, like quinine, nearly in equal proportions with the morphia, and found to have many of the qualities of quinine in the treatment of intermittent fevers. When in India in 1870, I was informed it was coming into large consumption in such cases, administered medicinally. It was to this principle I alluded in my evidence before the Committee of the House of Commons in 1871, as indicating a possible sanative power to the opium smoker inhabiting the low swampy deltas of the great Chinese rivers, and working under a tropical sun on a nearly vegetable diet, with a little fish or semi-putrescent cabbage — made so to increase the flavour. I also mentioned that when at Patna I was told another fact by the medical superintendent, of great significance. During the prevalence of cholera in India, it was found that none of the workers—men, women, and children, to the number of several hundreds—employed in the Government factory, in the preparation of opium for the market, seemed subject to attacks from this fell disease. And as they never left the factory without being subjected to the most rigorous and minute search, to see that they took none of the drug away with them concealed on their person, the prophylactic influence must have been exerted in their systems by the fumes, or more subtle emanations, from the poppy juice in its inspissated state. This fact, taken in connection with others, led me to believe that a similar preventive and sanitary effect may attend the use of opium in China, where dysentery and kindred diseases are very common, as well as malarious fevers.

I will only mention one other circumstance which has recently come to my knowledge, that in Cambridgeshire, where the people are also subject to fen fevers, a common use is made of opium as a remedy or preventive. And a Government Inspector of Schools, who had lately come into the district from one of the northern counties, was struck by the fact how much more peaceable and sober the working classes were than those he had lately been familiar with in the north, where no opium was consumed, but a very large quantity of alcoholic and fermented liquors.

I think I have said enough to show the importance of testing opium by some comparative standard, and letting its merits and demerits be tried by results and experience, in comparison with the rest of the large family of stimulants and narcotics; and abandoning for the purpose the moral ground, before we decide how far it may be held a sin to deal with any one of them, either as a producer or consumer?

The history of narcotics and stimulants is one of the deepest interest; but to do it the barest justice a whole evening, and not the small remnant at my disposal, would be required. To make up for this defect of time, I have had the large chart of the world now before you prepared, to show at a glance how wide-spread is the use among all the races, of narcotics and intoxicating products. It is only by such a survey of the proclivities and instincts of the human race, as these have been developed in every region where the different divisions of the family have found a habitation and a home—and under every clime and variety of conditions, physical and moral, —that we can descend from the general to the particular, and form a right judgment on the application of the knowledge thus obtained, as to the true bearing of any particular selection made in one nation or section of the whole category or family of narcotics and stimulants.

If we look at the chart, we see by the various shades and colours that the whole world is covered in tracts and belts, marking the *habitat* of certain specific products yielding narcotic and intoxicating principles for the common use of those who dwell within those limits. They number more than fifty in common use, over larger or smaller tracts of country—but in this chart I have limited the number to eight of the principal, to prevent confusion, following the small map given in Mr. Johnston's able and instructive work on the "Chemistry of Common Life," which everyone interested in the subject should read.

You could not well have a more striking demonstration of the wide distribution and variety of vegetable products yielding aliment to the craving of man for *some* narcotic or stimulant. The universality of the appetite is only equalled by the abundant—inexhaustible provision made by nature for its satisfaction in every region under the sun, and wherever man has found a home. And not only this, but the outer husk or form under which their narcotic and intoxicating principles lie hidden, is of such infinite variety that it may well be a matter for wonder and speculation how all races, in every stage of barbarism, have succeeded in divining their secret, and compelling them to yield their treasure for his use.

We read that when Columbus, in 1492, discovered a new world in the West, he found in Cuba a gentle race of natives, who, both men and women, had in their mouths rolls of leaves, from which they inhaled the smoke—a plant growing wild, and without care or cultivation, on their native hills. Who taught these simple savages the existence of a narcotic principle in the tobacco-leaf, and the art of enjoying its soothing properties by setting fire to it and inhaling the smoke?

Here are marvels not to be explained by any theory that would treat all such tastes as artificial, vicious, and sinful,—and exclude the whole family of narcotics from common use, in furtherance of an asceticism which, if it were not as impracticable as it is unnatural, would, if carried to its logical conclusion, relegate mankind to the order of ideas dominating the Monks of the Thebáid, who, separated from the world, rolled their black bread in the dust, lest they should find a sinful pleasure in its savour! Or a Simon Stylites, to stand on the top of a pillar until birds are said to have roosted in the hair, and his joints became fixed;—or his worthy brother recluse of Chinese sanctity, Bo-di-dar-me, or "wall-gazing" Brahmin, who turned his face against the wall seven years, that he might the better resist or escape from all carnal solicitations to sin or pleasure. This chart of humanity seems to me to read a very different lesson, and a different moral. Mr. Lowell, the American Minister, recently quoted an old saying that "there is a great deal of human nature in man," and the animal wants and conditions of that nature have to be counted with, as well as the spiritual. Here, at all events, from Cathay to Peru, we see the constant development of a desire for a stimulant and narcotic of some kind; and the lavish and ever bountiful provision made by nature to supply the want. Let us pass them in review. The poppy, the hemp, and the betel nut of a palm tree supply the chief narcotics and intoxicants of two-thirds of the globe, and the inhabitants of the two vast regions of Asia and the Eastern Archipelago. If we add the tobacco plant, the list is nearly complete. The betel nut, the seed of the areca palm, and betel pepper, one of the pepperworts *(pan)*; either betel leaf or siri, with betel nut and lime, constitute the narcotic mascutatory of the East, and is, perhaps, consumed by the human family as largely as tobacco. The intoxicating effect of betel, when chewed, is due probably, Dr. Birdwood tells us, in a work universally accepted as an authority, on the "Economic Botany of India," of the mutual reaction of the betel nut, betel leaf, lime and saliva. Happily the natives do not attempt, like the Kamschatkans, to transfer their organic products, thus made, to other recipients in its complete state.

Small quantities of spirit are said to be secretly prepared by the Hakims or Wieds from rosebuds, jasmine flowers, orange-peel, fennel seeds, &c. The juice of the common sugar-cane is made in the West Indies and elsewhere to yield rum, an intense intoxicant. And here is an illustration in the *Illustrated London News* of a half-naked native of Madagascar busily engaged in distilling spirit ferment with the aid of an old gun-barrel and a tub of cold water. Who taught these savages the complicated chemical process by which from the sugar-yielding cane, a valuable and most common and nutritious ingredient in healthy food, a poison to steal away his brains is made? Spirit and a kind of beer are intoxicants very largely consumed in Japan by fermentation and distillation from rice; and also in China, under the form of *Shamshoo*, a most potent and destructive spirituous liquor is in common use, especially in the northern provinces, where opium is less generally consumed than in the central and western provinces. If we pass from the pepperworts to the urticaceæ or nettleworts, we come to the common hemp, the bhang of Hindostan, cultivated in Europe for its fibre, but in Africa and Asia for the sake of its narcotic properties—another wonderful example of the instinct or faculty by which untutored and unscientific races—many without any tincture or leaven of civilization, unredeemed savages to this day, in Africa, for instance—discover in the most harmless and seemingly unlikely natural products of the vegetable kingdom, not only a narcotic and intoxicating property, but the means of extracting it for their use or abuse. Buretas, Livingstone, Burton, and many other African explorers testify to the wide use of hemp as a narcotic in Africa. Civilised man has turned hemp to another, but scarcely more fatal, use in connection with the gallows; an end to which the use of spirituous liquors in Christian countries so constantly brings its victims. The flowers of the hemp-plant are used in Morocco under the name of kief, and the "Assassins," or followers of the "Old man of the Mountains," are said to have derived their name from the use of haschish or hemptolis.

Perhaps there ought to be included the Sorgum or the larger milet, the product of which by fermentations is known as *Pombe* all over central Africa as the favourite beverage and intoxicant of all the savage tribes inhabiting that vast region. Burton says it is general throughout the country; all other intoxicating drinks such as plantain wine, toddy, and others being local. So universal is the vice of drunkenness among these savages, that we may comfort ourselves, whatever other sins may be laid to the charge of Europeans and their civilisation, that this vice cannot be counted as of foreign importation, for the natives had found in their own instinctive tendencies and indigenous plants; the fullest means of indulging the vice of intemperance to such excess, as to leave nothing to learn from Europeans in that direction.

If we cross the Ural mountains or the Mediterranean to Europe, we find fermented and alcoholic liquors reign supreme in conjunction with tobacco. These three are of such universal and habitual use that among the male part of the population the total abstainers must form a very small minority, while those who indulge in one or all of these to excess, I fear, must be numbered by millions. If, as is often alleged, alcohol, and the drunkenness arising from its abuse, is the bane and national vice of the British Isles, it cannot be said to be much less over all Northern Europe. Germany and the central populations are great consumers of beer and wine, and take their alcohol chiefly, perhaps, in that form; while the more southern portion of Europe—France, Spain, Portugal, and Italy—are wine-producing countries, and the produce of the grape is the chief stimulant of their respective populations, but it is much less abused. The Siberians in the north of Asia have their thorn-apple, from which they brew or distil their intoxicating liquors; and—such is the ingenuity of man, guided by a natural or a fatal instinct according to different opinion—the Kampschatkans have a fungus from which they brew a kind of ale. The *Amanita muscaria* is the fungus, which is steeped in the juice of the *Vaccinium uliginosum*, a wortleberry, generally used as an intoxicant. The mode of preparation and administration for this purpose is of so revolting a kind, that it cannot be described in any mixed company.*

Passing to the Western Continent, the very existence of which was unknown to us three or four centuries ago, the inhabitants of the Andes had the thorn apple and the coca leaf for solace; Central America its tobacco. But coca, the narcotic of the Andes, possesses two very remarkable properties not known to exist in any other substance—that of lessening, when chewed, the necessity for ordinary food, and not only enabling the chewer to put forth greater nervous energy for a short time, which opium does also, but with the same amount of food perseveringly to undergo more fatigue and long-continued labour. It also possesses another striking property, of preventing the difficulty of respiration which is usually felt in ascending the long and steep slopes of the Cordilleras.

So we read that the Hurkarah, who carries letters and runs messages in India, provided with a small piece of opium, a bag of rice, and a lump of bread, will perform incredible journeys. So also the Tartar, many days and nights continuously on horseback, whose only food is a few dates, and a lump of bread, with a small supply of opium, accomplishes his journey. The Turkish legend stamped on opium lozenges, "Mash-Allah"—the gift of God—seems well justified by these effects; and even horses are sustained by its influence. The Cutchee horseman shares his store of opium with his flagging steed, which, we are told by Major Burnes, thus supported, travels an incredible stretch. These are a few, and a very few only, of a large range of facts too numerous to be disregarded, and too well authenticated to admit of doubt; all tending to show that from different plants, all over the world, active principles are to be obtained, however different in outward seeming, which are possessed of certain valuable and characteristic properties, capable of exercising on the human frame characteristic narcotic and stimulating influences; one of which, and perhaps the most remarkable and difficult to understand, is a power of retarding waste or change of matter in the living tissues, and at the same time increasing the activity of the nervous system, in a manner and degree which the strongest soups or most nutritious food in any form cannot effect.

What are the inferences to be drawn from these facts and experiences? Our time, I am sorry to say, will barely allow me to glance in the briefest space at some of the more significant and important.

It has been truly said that "the craving for such indulgence, and the habit of gratifying it, are little less universal than the desire for, and the practice of, consuming the necessary materials of our common food."

This craving and demand for some form of stimulants and narcotics is not only universal, but the supply is equal to the demand, and inexhaustible. It is furnished by more than fifty well-known sources in the vegetable kingdom

This demand and supply, in which man and nature combine, points to a common want, *with a legitimate claim to be satisfied;* and, being so, no force that Government can bring to bear, by laws or compulsory measures, will ever avail to prevent production and consumption of this class of articles in some form or other, even if they could, which is doubtful, exclude any one, and determine the choice of the others. There is good reason to believe that many, if not all, of this class of narcotics and stimulants in various degrees, if not nutritious, in the sense in which food affords nutriment, is beneficial to great masses of the human race, by arresting waste and exhaustion of nervous energy, as a preventive of disease, and in many other ways too numerous to mention, when used in the moderation required in all things; and are not, therefore, to be prohibited as poisons. The great and most important conclusion to be drawn, therefore, from these facts is this—that a tendency which is so evidently part of our nature is not to be suppressed or extinguished by any form of statutory restraint, physical or fiscal. This has been tried in every form of compulsory and penal enactment, under the most despotic governments, with total and invariable failure for the result. We have heard a good deal of "force being no remedy;" and for this particular bias—vice or indulgence, however it may be characterised—force is not only no remedy, but hopelessly and absurdly inapplicable. We are told that "one touch of nature makes the whole world kin;" and the touch which binds the whole human race in one kindred here is of a narcotic and stimulant kind, however little it may be to the taste of a small majority of total abstainers, whose theory of life, I venture to think, is as much opposed to the teachings of Scripture and Christianity, as to the instincts of a common nature derived from the same Divine source.

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* See "Catalogue of the Economic Products of the Presidency of Bombay," compiled by Sir George Birdwood, 1862, p. 197.

That all these are capable of working serious mischief, demoralising and destroying those who become slaves to their use by a grievous abuse, is indisputable. But this is common to all, and not the exclusive property of anyone; and the tendency of each to lead consumers to this fatal state is to be tested by the observed effects over whole populations where its use is prevalent or universal, and not by the known effects on a minority who indulge to excess; and the per-centage of which, where ascertainable, should decide the question. Tested by this rule, nothing has been shown to prove anything exceptional in the effects of opium on whole populations, to justify any course of legislation or compulsion of an entirely exceptional nature not applicable to all the other narcotics or stimulants in common use, and notably, alcoholic and fermented drinks, in this country, and over the whole of Europe.

Comparing, indeed, the effects of opium on whole populations, or nations, it can be demonstrated, by evidence of an indisputable kind and overwhelming force, that the spirituous and other intoxicating liquors in common use in this country alone, work more mischief, and bring more ruin—sin and crime of every dye—upon the population of this country, and with it, greater waste and impoverishment to the people, than all the opium, foreign and native, consumed in China up to this day.

The amount spent by the Chinese at this date* for 100,000 piculs of Indian opium, the total annual importation, is £16,800,000, and for native-grown opium (assuming this to be in equal quantity, but at half cost), £8,400,000; making a total amount spent by them on this luxury, £25,000,000 annually; this being the supply for 2,000,000 smokers—those who consume the native product (one half of the nmber) spending about 5¼d. a-piece daily; the others about twice that amount per head—say 10½d. The amount of native opium grown cannot be ascertained; but if we assume it to be ten times the quantity here given, still the proportion of opium consumers to the whole population of some 300,000,000 as the lowest estimate, would not amount to 4 per cent. And if we limit the calculation to those which can be supplied by all the Indian opium imported, the result would be only 3⅓ in every 1,000, or less than one-third of one per cent. of the whole population of China. There is no evidence of crime and violence as the result of this habit or vice, even among this small fraction; and of crime in minor degrees, such as stealing and fraud to provide the means of a vicious indulgence, this must be limited to the percentage of the smokers who indulge to excess—which a preponderance of evidence shows must be small.

Now, compare this with what we know from official statistics of the consumption, cost, and effects of intoxicating liquors in the British Isles. The great complaint of Chinese Statesmen has been that the importation of opium impoverishes the people. And, in one sense of course, if money is spent in any luxury that can be dispensed with, it does impoverish those who cannot afford such indulgence. But, compared with this country, China is more happily placed, for its great national luxury only costs it £25,000,000, while it is estimated that the cost of strong drinks or intoxicating liquors of all kinds to us, is not less than £142,000,000, which, divided among the whole population of some 35,000,000 would be about £4 10s. per head, while a capital of £300,000,000 is further estimated to be invested in their production and sale. The whole sum in China, on opium, so far as we can estimate the native produce, would, among the 300,000,000 of population, be only one penny per head. But the impoverishment due to either article is of far less importance than the effects in the production of crime and brutal violence of every kind, filling our prisons and feeding the gallows. Nothing has ever been said of opium that can equal the evil which has been written and spoken of strong drinks. Judges from the Bench, and preachers from the pulpit, vie with each other in denouncing this as a national vice, destroying both body and soul, and bringing widespread ruin on a vast population. The judges, who administer the law, lament their powerlessness to stop its terrible ravages. The clergy declare it to be the most formidable stumbling-block in the way of Christianity. We are told that nine-tenths of the 40,000 prisoners in our jails are there for crimes committed under the influence of drink; and, in a paper by Dr. Norman Kerr, read lately at the Social Science Congress, the annual mortality from drink is estimated at 128,000, while the number of habitual drunkards reaping this harvest of death and misery to all belonging to them, is put at 600,000. I do not vouch for the accuracy; I am only quoting the figures confidently put forward by the advocates of a total abstinence. But in the way of official statistics, we have the best authority, that of the present Home Secretary, who publicly stated, in speaking of crime and the connection of spirituous liquors with it in the British Isles. Reading from a Report of the Commissioners of Prisons, of July, 1881, he showed that the number of prisoners sentenced in the ordinary courts had been 149,074, and in previous years much larger. He also said he entirely agreed with Sir Wilfrid Lawson, that one of the greatest and most fertile sources of crime had been, and still was, indulgence in strong drinks. By far the largest number of cases which resulted in murder "were crimes largely committed under the influence of drink. Those convicted of the offence of drunkenness and disorderly conduct in 1879, were 178,429, and in 1880, 172,259." I do not think anyone who has lived in China will believe that this number, or any number approaching it among opium smokers, are ever convicted of crime or disorderly conduct. They may, when slaves to the habit of smoking, such percentage of them as can rightly be classed with drunkards here, impoverish and ruin their families, as well as their own health—but no one ever heard of an opium smoker going home from his debauch and brutally assaulting his wife, kicking her to death, or murdering his children.

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* See "Yellow Book on Opium," published by order of the Inspector-General of Customs, 1881.

The advantage of such a comparison is so entirely on the side of opium and its smokers, that I do not wonder those who agitate for the suppression of the trade should object vehemently to any such comparison being instituted; not because they can deny a strong analogy and parity of reason, applicable in considering the practicability or expediency of compulsory laws and other Government measures to put an end to the consumption of opium—by cutting off the supply and rooting up the poppy wherever it grows; but on the alleged ground that no foreign nation has compelled England to let liquor in—whereas, we have had two opium wars with China, and are still forcing the trade upon them. As to the accuracy of both these statements, I need say no more on the evidence of the *bonâ-fide* desire of the Chinese to effect the total suppression of opium smoking. Of their desire to stop, or if not able to stop, to turn the importations of foreign opium to greater profit in a fiscal sense, I have, indeed, very little doubt. I am accused of having stated in my evidence in 1871, that I had no doubt of the Chinese ministers' sincerity when urging me to aid them in suppressing the trade. I might answer, as a Prime Minister answered, not so long ago, when twitted with an apparent variation of opinion before and after the Treaty of Berlin—"A great many things have happened since then." But, notwithstanding the open and official encouragement of the native culture by Imperial sanction, and license for taxing it, and the vast development it has taken in the twelve years' interval since I left Peking, and Li Hung-Chang's last change of front in proposing to farm or purchase the monopoly of all the Indian opium, I will simply say that neither now, nor when negociating, did I see reason to doubt that they were in earnest in their desire to get the entire control of the opium trade, and more especially the Indian trade; but with what motive, or to what end, I was not so satisfied, and therefore I proposed to put them to the test, by suggesting a loyal and effective co-operation between the two governments to restrict the area of cultivation in both countries as the only course likely to prove effectual—while increasing the duty on the Indian drug—leaving them free, as they have ever been, and are to this day, by treaty, to levy any duty they pleased upon its transit to the interior, and before it came into consumption. The whole object of Li Hung Chang's latest negociations with my successor, Sir Thomas Wade, has been to make more sure his first levy of this excise or transit duty, by being allowed to enforce its payment within the port, and before it passes into Chinese hands. I am also charged with having said in evidence that undoubtedly China was forced to admit opium. Quite true. But after the Treaty of Tientsin, they had of their own will placed opium on the tariff of articles that might be legally imported on payment of a fixed duty. From that date they were bound by treaty to admit it—and in that sense forced to admit—but not otherwise than they were forced to admit every other article in the tariff. But this is a small matter. We are told that any argument derived from the greater evil inflicted by spirituous liquor than opium is wholly irrelevant, not only because the latter has been forced on China, but because opium is a poison, and has been so declared by Act of Parliament, and cannot be considered an article of food, or as ministering to health. Well so has every kind of alcoholic and fermented liquor been declared to be a poison by quite as great an authority as an Act of Parliament. Dr. Andrew Clarke, a physician of the greatest eminence in this metropolis, stated recently in a public lecture, "Alcohol is a poison; so is strychnine; so is arsenic; so is opium; it ranks with these agents." Here, you see, this great medical authority classes alcohol and opium in the same category. It is true he calls them all poisons; and so they are to all who do not know how to use them. But on alcohol, as the great destroyer, he lays the greatest stress. He says health is a "state, which in my experience is always in some way or other injured by alcohol." He adds, that in going the round of his hospital wards, one of the largest in London (St. Bartholomew's), seven out of every ten he found there owed their ill-health to alcohol. Sir William Gull gave evidence before the Lords' Committee, "that a very large number of people in society are dying day-by-day, poisoned by alcoholic drinks. I hardly know any more powerful source of disease than alcoholic drinks, I do not think it is known, but I know alcohol to be a most destructive poison. I should say, from my experience, that it is the most destructive agent that we are aware of in this country." Sir Henry Thompson, in a letter to the Archbishop of Canterbury, states as his conviction that there is no greater cause of evil, moral and physical, in this country, than the use of alcoholic drinks—I do not mean by this, that extreme indulgence which produces drunkenness — the habitual use of them to an extent, far short of this, injures the body and lessens the minds power to an extent which I think few people are aware of." And he gives, as the result of his observation during more than twenty years of his official life, devoted to hospital practice and to private practice, and every rank above it, that "a very large proportion of some of the most painful and dangerous diseases arise from the common and daily use of fermented alcoholic drinks, taken in the quantity which is ordinarily considered moderate." And the late Dr. Murchison speaks of "the brittle artery, the softened heart, the gouty kidney, and premature decay, which might never have occurred had it not been for the daily dose of alcohol which induced an unnatural character of the tissues, and the circulation of an impure blood." Nothing worse has ever been said or imagined of the effects of opium; and these are all the opinions of men of large experience and of the highest authority in their profession.

I say, then, that we are irresistibly led to the inference that opium is the lesser evil of the two; and, if it could even be assumed to be as deleterious in its action on the individual as alcohol, it must be admitted to be infinitely less injurious, hateful, and dangerous to the community. I have lived the last twelve years in this great city of beer and spirit-drinking people, after more than twenty passed in the midst of dense populations of opium-smokers, and I can conscientiously aver that I see more degradation and brutality in a single day in the streets of London—more of violence and misery, with danger to all who come in contact with it—than I ever saw in twenty years of life in China; and I would rather live, so far as personal safety and freedom from outraged feelings for humanity, in a heathen population of opium smokers, than in a Christian community, where drunkenness from alcoholic drinks is the prevailing vice among the mass and working classes. And if this evil be as great as all these authorities have described, and our own experience of daily life confirms, and yet no law or compulsory legislation has been found available to stem the torrent of vicious indulgence in drink —with a Parliament that is well nigh omnipotent, so far as the making of laws is concerned —with power over a man's life, liberty and property—who is it that dreams of making a vast Empire like China, with its three or four millions, and 12,000 miles distant in the far east, virtuous and self-denying in the use of narcotics or stimulants by compulsion and Imperial edicts?

It was the profound conviction based on a world's experience, as that chart describes it, and as the history of our own and every other country exemplifies, of the futility of all such attempts, and such as China has made during the last 100 years in its customary spasmodic and inconsequential way with all the autocratic power vested in its Emperor, and most corruptly administered by his high officers and officials of every grade, that determined me, as it determines me now, not to be a consenting party to the sacrifice of a most important part of the Indian revenue, without which all order, law, and Government, would be impossible over a population of 250,000,000 of subjects for whose well being we are directly responsible; and in addition, the derangement of a vast commerce involving honest trade and vested interests of colossal proportions, not in India alone, but in China and the whole British Empire. And all for an ideal result as utterly impractical in its conception, as it was impossible of realisation under any conceivable circumstances. There was but one thing realisable and certain about it, and that was, that if, by any of the many possibilities in our representative and party Government, a vote could be in some form obtained, decreeing the abolition of the opium culture and trade in India, the sudden dislocation of all the administrative machinery and industrial activity of the Indian Empire would be the first and immediate result. Ruin, in one or many forms, to the whole fabric of our rule would speedily follow, without the slightest benefit to China or the Chinese, for whose welfare our philanthropists are so intensely anxious, while they can rest in peace under the dark shadow of sin and misery and crime at their own doors, unchecked and unheeded, proceeding from the demon drink. Opium is grown by the Chinese in the larger half of their own territory, and over an area vastly exceeding that employed in India, and will continue to be so, whatever may be the course followed in supplying opium from our territories. And if it were conceivable that the Chinese supply should fail, under some new-born zeal and vigour of their own Government, the void would be filled from every opium-growing country—from Egypt, Turkey, Persia, Malwa; from Africa, where already, at Mozambique, the Portuguese have made a great concession to an opium company, and the culture is proceeding — from every tropic region, and carried under every flag but our own. The China seas must become, if all such trade were prohibited—what they were for a century before we performed the police of those regions for them, at our own cost and peril—infested with pirates and smugglers, where no legitimate or honest trade could survive. Millions would suffer in such a reign of violence and disorder, but not an ounce less of opium would reach the Chinese coasts, and not a single Chinaman would find that virtue which depends on relief from temptation and from self-denial, and the will to do right. The advocates for a suppression began at the wrong end, as I told the Chinese Minister in 1869—they want to cut off the supply, and should find means to prevent the demand—not by compulsion, which always has failed, but by moral persuasion and education; and with the cessation of the demand, the supply will cease of itself, without any effort of philanthropists or governments, and in no other way can the end they seek ever be compassed.

I have no fancy myself for tilting at windmills, but if there be any well-intentioned and philanthropic enthusiasts who have, I cannot but think they would do better to try their powers on those nearer home; and there is one of colossal proportions ever ready for the assault at their own door, which I firmly believe works more destruction in a day in this land, than opium in a year amongst the millions of China.

DISCUSSION.

Mr. H. F. RICHARD, M.P., after disclaiming any authority for a paragraph which had appeared in the morning papers, that he had come there to state the case of those who advocated the abolition of the opium trade, said it was true that he had taken considerable interest in this subject for a great many years, and might be allowed to make a few observations on what he had heard. One preliminary remark he thought would be generally admitted to have some force, and that was, in attempting to form a sound and impartial judgment as to the character of this traffic, there was one disturbing element of a very serious kind, against which everyone must be on their guard. Whatever might be the merits or demerits of the case, one thing could not be lost sight of, that it was an enormously profitable trade both to the Indian Government and, indirectly, to the British nation; and when interests, whether personal or national, were deeply involved in any question, they had great power of throwing dust into the eyes of the reason, and numbing the sensitiveness of the conscience. He was surprised at the turn this controversy had taken in the last month or two, for until then, he thought there were certain things universally admitted; in the first place, that opium, except as a medicine, was a poisonous and pernicious drug, and that the habitual use of it for the purpose of sensual gratification was a vicious and degrading habit. For that they had the opinion of some of the most distinguished medical men who had ever lived, and amongst them were Benjamin Brodie, Drs. Bright, Chambers, Fergusson, Holland, Hodgkin, and a number of others; besides that, they had the authority of a large number of gentlemen who had been officials in India and China, as to the mischievous effect of this indulgence on the Chinese themselves. He could cite the opinion of such men as Sir Stamford Raffles, Sir George Staunton, Sir Charles Hall, Sir John Davis, Colonel James Starr, Captain Sheppard, Henry St. John Tucker, a former chairman of the East India Company, Sir Arthur Cotton, and a number of others, and he would give two or three sentences from the opinion of the last gentleman, perhaps the most distinguished of the whole. He said, after an experience of 25 years, "It is to me vain to think otherwise of the use of the drug in China, than as a habit many times more pernicious, nationally speaking, than the gin and whisky drinking we deplore at home." They also had the testimony of medical gentlemen from China itself, who had been actually practising there, and who had been witnesses of the effects produced by opium—men like Drs. Parkhurst, Locker, Hobson, Dempster, Fletcher, Smith, and many others. Besides these, they had the opinion of Christian missionaries, who ought not to be lightly put aside; they knew the effect this habit produced, especially in thwarting their attempts to commend to the Chinese the Christian religion. Sir Rutherford Alcock had quoted Dr. Medhurst, who, he said was one of the most eminent missionaries in China, but he had with him the opinion of Dr. Medhurst on this matter, from which he would read two or three sentences. When he wrote them, he had been 22 years in China. He said, "When the issue of this pernicious habit is not fatal, its tendencies are to weaken the strength, to undermine the constitution, while the time and property spent in its production constitutes so much detracted from the wealth and industry of the country, and tends to plunge into utter distress those weak and dependent members of society, who are already scarcely able to exist at all, in fact, every opium smoker may calculate on shortening his life ten years from the time he commences the practice; one half of his physical energies are soon gone, one-third of his scanty earnings are absorbed; calculating, therefore, the shortened life, the frequent disease, and the actual starvation, which are the result of opium smoking in China, I am able to assert that this pernicious drug annually destroys myriads of individuals." The great point of the reader of the paper seemed to be to call in question the assertion made by those agitating in this matter, that opium had been forced on the Chinese. He had always thought the evidence on that matter was overwhelming. What did the Chinese Commissioner engaged with Lord Elgin about the Tientsin treaty say; there was a pressure of armed force, and a state of excitement and alarm, and a treaty had to be signed at once, without a moment's delay. Therefore the Commissioner had no alternative but to accept the conditions forced on him; nor did Lord Elgin call in question that interpretation of the matter. He wrote himself that the concessions obtained in the treaty from the Chinese Government amounted to a restitution, and had been extorted from its fears. Still stronger, if possible, were the words of Sir Thomas Wade, writing in 1868: "The concessions made to us have been, from first to last, extorted against the conscience of the nation, in defiance, that is to say, of the moral convictions of its educated men." Another very distinguished gentleman, who was for many years in a high position in China, said, "To keep as clear as possible of all foreign Governments is a very natural desire on the part of those who twice, within a single generation, had had objectionable treaties forced upon them at the point of the bayonet." Those were the words of Sir Rutherford Alcock; and he must say that a great deal of what he knew about China, and the opinion he held as to the conduct of Englishmen in China, he had derived from the writings of Sir Rutherford Alcock. Before a Committee of the House of Commons, in 1871, being asked whether the opium traffic had not been one great reason of weakening the Government, and introducing anarchy in China, Sir Rutherford Alcock answered, "They say so; and I should think the very fact that they had been compelled by the superior force of foreign Governments to admit it, against all the moral feeling and judgment of the nation, and against their own, as an article of commerce, must very much damage them in the estimation of the people first, as a sign of deplorable weakness, next, as a witness of want of courage to do what is necessary for the welfare of the nation." He gave some further answers to the same effect. Another great point made by the lecturer was to call in question the sincerity of the Chinese Government in its resistance to the introduction of the drug, but the evidence on that point also was very strong. His opinion on the matter, of course, was worth very little, but if nobody was to talk about this question except those who had been in China, they must all be dumb. What could they do, except take the testimony of those who had been to China, and he would give the testimony of one of those who were most honoured and respected. This gentleman met the Viceroy of India, in council, on the prospect of Indian finance, and the question of opium, and the objection made by the Chinese Government to its admission, came up, when these were his words: "He had no doubt that the abhorence expressed by the Government of China for opium was genuine and deep seated, and he was also quite convinced that the Chinese Government would have been pleased to carry out its threat of developing the cultivation to any extent. On the other hand, he believed that so strong was the popular feeling on the subject, that if Great Britain would give up the opium revenue, and suppress the cultivation in India, the Chinese Government would have no difficulty in suppressing it in China, except in the province of Yunnan, or where its authority was disputed." The same distinguished gentleman gave his testimony again, later on in 1871, before the Committee to which he had already referred. He was then asked if the Chinese Government did not derive a large revenue from Indian opium, and whether that did not lead them to encourage it. He answered—"They do derive a large revenue, and I estimate the amount they receive would not be less than about one and a-half millions sterling. They have shown the greatest readiness to give up the whole revenue if they could only induce the British Government to co-operate with them in any way to put it down. My own conviction is firm, that whatever degree of honesty may be attributed to the officials and Central Government, there is that at work in their minds that they would not hesitate one moment—to-morrow if they could—to enter into any arragement with the British Government, and say, let our revenue go, we care nothing for it, what we want is to stop the consumption of opium, which we conceive is impoverishing the country, and demoralising and brutalising the people." Those again were the words of Sir Rutherford Alcock. He maintained that the Government could put down the trade at any time they like, but what more could they have done than was done by Commissioner Lin, when he seized 20,000 chests, and destroyed them. The reader of the paper objected to call this war an opium war, but he did not; he believed it was essentially an opium war. There were a lot of British smugglers who were trying to force this offensive drug on China, against the laws of the country; and when they insisted upon it, and refused to deliver up the obnoxious article, they barricaded the factories, as they had a perfect right to do, until it was given up, and when given up it was destroyed. It might be asked, why since that time had they not taken more vigorous measures? But they, doubtless, remembered that when on the occasion they protested against the introduction of the drug into their country, which led to a disastrous and sanguinary war, during which Canton was repeatedly taken, many towns and villages ravaged, 30,000 or 40,000 people slaughtered, three or four millions sterling extorted by way of the expenses of the war, besides six million dollars to compensate the opium smugglers for the opium which the Chinese had seized and destroyed, which he considered they had just as good a right to do as the English Government would have to seize a cargo of smuggled French brandy. When they found their arguments were answered by cannon balls, no one could wonder that they should avoid as much as possible any differences of opinion leading to such results. With regard to the question of the liquor traffic in this country and its evils, he did not see that that affected the argument in the least. It was condemned alike by magistrates, judges, ministers of religion, and medical men, but he did not see how its existence bore on the question before the meeting.

Mr. Rowland Hamilton said he felt bound to come forward and speak on what was certainly the unpopular side of this question, because he thought he had something to say upon it, having been one of the mercantile community in China, though entirely dissociated with opium. It was more than twenty years since he was there, that was just about the troublous times, when Shanghai was beleaguered by the "Taeping" rebels, and under those exceptional circumstances he saw a good deal of the Chinese refugees in the settlement. Subsequently, at the beginning of 1861, he was one of the first expedition which proceeded into the interior of China, after the Treaty of Tietsin. He was in company with several others, one a gentleman of the missionary body, and several consuls and others, and they took every opportunity of seeing all they could see of the Chinese with whom they came in contact; and he would state as shortly as possible the conclusions at which he had arrived. In the first place, he found that in all parts the Chinese generally did use opium. Nanking was in the occupation of the Taepings, and nothing could exceed the rigour of their denunciations of the opium traffic, but still they found there was one thing for which silver would be given, and that was opium. Then they went to a large provincial capital opposite Hankow, where they were received with great civility by the authorities, and, amongst other things, they were shown the cells where a large number of students assembled for the highest examinations, except those held at Peking; and in the course of conversation, they were told that the students remained there sometimes two or three days, having with them their books, provisions, and if they liked it, opium; it was mentioned as quite a matter of course. Notwithstanding all this, they found it was a term of reproach to say that anyone was an "opium smoker," for that means in China exactly the same as it does in England, to say that "a man drank." If he were to say of any gentleman in that room that "he drank," he would be making a grave imputation against his character, and he should not be justified in saying so of anyone who used wine, as a large majority of sober people did. He was convinced that the cases of excess in the use of opium, were very much as they were in England in the case of alcohol, confined to the idle and the dissolute rich, and to those who were ill-fed, ill-clad, ill-housed, and suffered from all the worst evils of poverty. He would not dwell further on this point, which would be fully investigated by those of medical skill, but would venture this remark, from practical experience both in India and China, that no authority in England who had not studied the use of these drugs in the country could possibly give an opinion upon them which would be valid as to their effects *there*. What he would rather speak of was the more social and political aspects of this trade. He personally had known two agents of the old East Indian Company, before the trade was opened, but they could not remember a time when the one thing for which the Chinese would bring their silver was opium. Again, in 1842, one well-known merchant acted on the opinion that neither the war nor any other obstruction would check the "effective" demand of the Chinese for this drug, and the result verified his views. They were sometimes apt to forget that in dealing with the Chinese they were dealing with a very old civilisation. They had cultivated literature, and were perfect masters in the art of diplomacy. No people were so fond of using high-flown aphorisms, which had not the slightest connection with what they actually did. On one occasion, coming down to Yangste with Mr. Parkes (now Sir H. Parkes), they stopped at a little Chinese city which had escaped the attack of the Taepings. He was not a Chinese scholar himself, but Mr. Parkes kindly kept him acquainted with the nature of the conversation as it went on. Point after point was given showing how hopeless the position of the rebels was, how the advance they had just made was unsupported, and how they must necessarily fail; what struck them most was the exceedingly sensible and practical way in which all this was brought forward, but this did not for one moment shake their conviction that no practical measures would be taken, or even attempted; and so it proved. He could not believe that those of the literati and others in Peking, whose official duty it was, as censors, to read lectures to the Government, were within the lines of the practical policy of the country. They might believe in their personal sincerity, but not that these literary essays had any effect on the practical policy or morality of the Chinese. When he first went to China, in 1858, the *de facto* governments in the provinces were the only authorities with which they could deal. For instance, he had certain Manchester goods coming to him, in Canton, which he wished to pay full duty upon, according to the treaty, 5 per cent, but he found the existing local governments had arranged with the Chinese "Hong" merchants for about 3½ per cent. No one accessible to us had power to receive more. The only thing he could do was to join with the large body of merchants, who lent all their influence in favour of starting an organised Custom-house under European influence, and it was this which had given the Imperial Government its revenue up to the full limits allowed by treaty. Those in Peking talked about what they would do in China, but it was notorious at that time that the Imperial Government was starved, and although it had the shadow of authority, and could issue edicts, had no practical power, either to get revenue, or to control the resources of any one of its 18 provinces. He felt most distinctly that the only choice there now was, or ever had been, was between acknowledging the trade and keeping it within such rules as could be enforced, and leaving it open to all the evils of a contraband trade. He should most earnestly depreciate the idea of our making the Chinese a *corpus vile*, on which to try an experiment in sumptuary legislation which never had succeeded and never would be likely to succeed in any civilised State, and this, too, in connection with a Government upon whose efficient practical support we could in no way rely. Such a course could only entail vast evils on the whole country of China. Let those who had reason to believe in the sincerity of Chinese reforms, and who wished to promote the cause of temperance, attempt to do what had been done in England, and meet the evil in the way in which they knew was the only way of attacking it here, by providing healthy homes, better employment and means of recreation, and bringing positive, not sentimental, morality to bear on the minds of the people.

The CHAIRMAN said he should be glad if the speakers would address themselves to the real point raised by Sir Rutherford Alcock's address, that admitting the evil of opium, assuming that we had by treaty enforced reception of opium upon China, whether the Chinese were in earnest in wishing to put it down, when this fact existed; that over one half of China, not reached by the British opium trade, the cultivation of opium was openly carried on. Because the very able Secretary of the Embassy, Mr. Baber, who was well-known in the Geographical Society, and who had lately travelled over the western provinces, stated that in one province alone, Yun-nan, there were over 1,000 square miles devoted to the cultivation of opium. What occurred to him, as one who had not gone much into this subject, but who was really anxious to be informed, was this, could they, with respect to any other people, think that they were in earnest in trying to prevent the admission of a drug, when they themselves permitted the open cultivation of it to such an enormous extent. It might be very different to put down smuggling, and he could understand to some extent the spasmodic attempts made by the Chinese, before the Treaty of Tientsin, to put down the illicit trade in opium. They allowed it to go on at times, and drew revenue from it, but at other times they endeavoured to suppress it. That was not the way to suppress a trade. Those efforts showed that from time to time conscience, or interest, or some other motive, induced them to assert the law; but what could they say as to their earnestness when they permitted this enormous cultivation. That was one point he should be glad to hear an argument upon, and the other point was this. It was said that, if the trade regulated by the Treaty of Tientsin, were put an end to, other countries would rush in and supply the void, and that the smuggling carried on more or less openly before the treaty, would be practised not by one nation only, but by a dozen, and that the Chinese would be as helpless as they were before to prevent it; and that we should be, therefore, inflicting on our Indian fellow-subjects an enormous mischief, without any compensating advantage. Those were the two points on which he had not yet heard one word said, and he should be very glad if any gentleman connected with China or India, or with any trade, were able to enlighten the meeting on these two points.

Sir GEORGE BIRDWOOD said the only point with which he had concerned himself was whether opium was in the same category as alcohol or not. It might be admitted at once that opium was a most powerful poison, and so was cobra poison, though when diluted in the form of human saliva, it was necessary for the digestion of food by man. It seemed to him that one vital question was whether opium and alcohol were really referable to the same category.

The CHAIRMAN said he did not think this was the vital question; the vital question was, whether China was in earnest in wishing to put down the opium trade. That mischief arose from it could not be doubted.

Sir GEORGE BIRDWOOD said when this matter was before the Committee of the Society he was requested to give some remarks on the point he had mentioned, that being the only point on which he was qualified to speak, or on which, considering his official position, he ought to speak.

The CHAIRMAN said he was quite certain that a gentleman of the high position of Sir George Birdwood would confer a great benefit if he would raise the question of the use or abuse of opium as a separate subject. He would suppose this had happened in England—that some modified form of Sir Wilfrid Lawson's Bill were adopted, and that every county in England had been led to adopt it; that that Bill, when it came into force, would actually put an end to the sale in every shape of spirituous liquors. The logical conclusion would be that the Government would then interfere to prevent the introduction of liquors and spirits, inasmuch as under its authority every portion of Great Britain had adopted an Act which suppressed the sale, and, therefore, the use of spirituous liquors, the Government would be forced to prevent their introduction into the country, as that could only lead to the evasion of the law. It seemed to him that under such circumstances they would not allow France for one moment to argue that alcohol in certain proportions was useful. It would be enough to say that this country had declared against it, and they would exercise the power of saying that what the people had declared to be mischievous should not be introduced. Therefore, it seemed to him it was quite idle to argue to what extent opium was injurious or not. If the Chinese Government had arrived at the conclusion that it was injurious to their people, they had a right to say so—at any rate, the same right that we should have to exclude spirituous liquors. But then came the question, was this a really sincere desire, or had the Chinese shown by their acts that they were really in earnest. There were plenty of words, but what were their acts; and then came the question, had they the power to prevent the introduction of it, as we should have to prevent the introduction of alcoholic liquors if the Legislature passed an Act, prohibiting their use.

Sir GEORGE BIRDWOOD said, that if the discussion was to be limited to the commercial and political aspects of the opium question, he could take no part in it, as he was only prepared to defend the use of opium as a contra-stimulant. He might, however, be allowed, in reply to Mr. Richard, M.P., to quote from Sir Benjamin Brodie's "Psychological Studies," p. 248, the exact words of that illustrious physician in comparing opium with alcohol, viz :—"The effect of opium when taken into the stomach is not to stimulate, but to soothe the nervous system. It may be otherwise in some instances, but these are rare exceptions to the general rule. The opium-eater is in a peaceful state, satisfied with his own dreamy condition while under the influence of the drug. He is useless, but not mischievous. It is quite otherwise with alcoholic liquors."

Major MANN said he should not have ventured to address such a meeting, but the Chairman had asked for information on two points. First, was the Chinese Government sincere in its desire to stop the opium trade, and that question, though he did not pretend he could answer it entirely, he could answer with regard to one very large district of which he had been in charge, as far as the Customs were concerned, for five years. That district was not one of the 18 provinces which Sir Rutherford Alcock had enumerated, but it was the district outside the Great Wall of China, called Manchuria, and therefore the figures he should give would be in addition to those of Sir Rutherford Alcock. That great district, which was larger than the province of Sz-Chewen, was, like it, according to Mr. Baber's statement, also covered with opium; from one end of those three provinces to the other, the opium plant—the poppy—was openly grown on every road-side, and very often within the cities. In parts which a few years ago had become wasted, owing to the drain of fighting men taken south to supply the Chinese armies, there were now, in consequence of opium-growing, an influx of agricultural population. All that was going on under the eyes of the Chinese Government.

The CHAIRMAN asked if opium were imported at all into that country.

Major MANN said it was, but not now. When he first went there in charge of the Customs, the opium trade was very large, and there were two British houses engaged in it, doing a large business, besides what was called the Opium Guild, but when he left it, after an interval of seven years, both those houses had been shut up, because there was no longer anything for them to do, the native opium trade having increased so enormously that their trade had left them. The Chinese Government recognised the trade, because they levied an inland duty on opium, and also levied a differential duty on land used for the cultivation of opium.

The CHAIRMAN asked if the Government could, if it wished, suppress the cultivation.

Major MANN said undoubtedly. The country was very thinly peopled, and they had a large garrison there in consequence of its proximity to Russia. He should be sorry if any one went away with the idea that he was not a friend to China or the Chinese Government; so far from it, he was called by his friends a Chinaman, because he spoke the language, and was very fond of Chinese people.

The CHAIRMAN asked if it were his opinion that the abolition of the opium traffic, as between India and China, was a condition precedent to putting down the cultivation of the opium plant in China.

Major MANN thought they could not stop the importation of the foreign drug.

The CHAIRMAN said—Supposing by treaty the English Government undertook to suppress the large importation of opium which now took place, would the government then in China take heart to suppress the cultivation of opium ?

Major MANN said certainly not ; on the contrary the cultivation would be increased. It was to their interest to increase the opium trade, particularly on the frontier.

The CHAIRMAN said it might be to their interest, but against their moral conscientious opinion. What was Major Mann's explanation of the fact that the Chinese Government had, through its accredited organs, expressed the strongest desire to suppress this traffic ?

Major MANN said he knew the Peking Government had done so at various times, but he did not believe they expressed the feeling of the nation.

The CHAIRMAN asked what was their object in putting this forward, if they were themselves cultivating it.

Major MANN said the Chinese were a literary people, very fond of writing, and these things sounded very well in essays, but nobody believed them. He did not think there was any other explanation.

The CHAIRMAN said there were a number of gentlemen present, of the highest medical reputation, whom he had no doubt could give the most valuable information as to the effects of using opium, but he did not think that was really the point for discussion, which was the opium trade, and especially the two points he had already mentioned. If there was any gentleman present who wished to speak on either of those, he should be glad to hear him.

Mr. DAVID MCLAREN (Edinburgh) said he had not been in China, but had given a great deal of attention to this subject, and was prepared with almost all the quotations Mr. Richard had given in answer to the statements of the reader of the paper; and he frankly confessed that if it had not been for the announcement who the speaker was, he should scarcely have imagined it was the same gentleman as the one cited by Mr. Richard, His Lordship had now raised the question of the sincerity of the Chinese Government, but he might be allowed to ask whether there was not a prior question, namely, whether the Chinese Government were sincere or not, was England entitled to force upon it any measure which, for whatever reason, they chose to oppose ? Probably very many people in the room were not aware of the fact, that at that very moment the importation of opium into India was forbidden. The first article of the Indian Act was—" The importation of opium is hereby forbidden." What would they say of the Government of Persia or Turkey, if they occupied the same position towards England as regards power as England did to China, were to say—" You are insincere in this proclamation ; you are only doing it for the sake of your own revenue, and, therefore, you must admit opium from us?" The prior question was this—sincere or not—was England entitled to force it upon the Chinese ? The Japanese refused it, and we had not forced it on Japan.

The CHAIRMAN said that on the occasion of the treaty of Tientsin, a vast number of other articles besides opium were admitted, which he understood the Chinese would gladly have excluded, and one result of the treaty was, that they were compelled to have commerce with us. The speaker had very properly raised the question, whether we were entitled to force Japan, China, or any other country to trade with us ; but assuming we had the power, we certainly had exercised it, and then came the question—why was opium to be distinguished from cotton or anything else. Then it was said that opium was deleterious and cotton was useful ; but the answer to that was, China itself was now raising this deleterious drug and beating us in the market.

Mr. MCLAREN said he did not think there was any analogy to be drawn from two such countries as England and France, to two countries like England and China. The condition of the Chinese Government was not at all to be compared with the condition of any other Government with whom we had diplomatic relations. Was it fair to the Chinese Government which has been weakened very much by our own wars, and is not able to enforce its own views ? It was not so much the question of the sincerity of the Chinese Government, as its power to carry out its own decrees. Sir Rutherford Alcock had no doubt whatever of their sincerity, for he said there was that at work in their hearts and consciences which would make them disregard all questions of revenue.

The CHAIRMAN said he could not see how the growth of opium on so large a scale was consistent with those statements.

Mr. MCLAREN said was explained by the weakness of the Government, and the venality of its officers. With what grace could the Chinese prevent their own people growing poppies, if at the same time they received opium from India. Here is a governor, who has on the one side a native grower of poppy, and on the other, a foreign vendor of opium ; how can he prohibit the former, while obliged to tolerate the latter ? That is actually the case mentioned by Major Mann.

The CHAIRMAN remarked that in this country it was forbidden to grow tobacco, although it was imported from abroad.

Mr. MCLAREN said if the English Government were to become as weak as the Chinese, the Excise officers would be amenable to bribes, and then tobacco would be grown.

Mr. DONALD MATHESON said his only claim to address the meeting was some experience he had had in former times in China, he having been there in 1839, and having been himself one of the prisoners in Canton when the opium was seized. From that time he had studied the subject a great deal, and some few years afterwards, in Hong Kong, he had inquired a good deal among the Chinese with regard to the effects of this trade. His firm belief was that if the Chinese people were polled, they would, by a large majority, denounce it. He had seen many men, brokers and others, who said they had commenced to smoke opium two or three years ago, and now they could not stop. It was a common saying there that when a man smoked opium, he was making his own coffin, and he could give instances which had come under his own observation of the deleterious effects which it had produced. In 1839 there was strong proof of the Chinese being in earnest, for they gave due warning, and executed in front of the factories some of those natives who had been detected in the trade.

The CHAIRMAN asked if Mr. Matheson thought public opinion would support the Chinese Government in suppressing not only the trade but the growth of the plant?

Mr. MATHESON said certainly.

The CHAIRMAN asked why did they allow it in that case?

Mr. MATHESON said there were eighteen provinces in China, amongst which, of course, there would be a great variety of opinion; those in the western provinces were different to those in the east.

The CHAIRMAN said he understood from Sir Rutherford Alcock that the western provinces did not receive opium from India, but that all they used they grew themselves. Why did the Chinese Government permit that part of the population which was uncontaminated by the trade with India to grow this plant for their own corruption and destruction?

Mr. MATHESON said the great distance from the seat of power in Pekin was one reason, and another was, that the Government had great difficulty in keeping out foreign opium. Besides this, there were different policies in China, and different parties, just as there were Whigs and Tories here; at one time the Ministers would increase the growth, in order to counteract the importation of the foreign drug, and at another time they would make violent efforts to put it down.

The CHAIRMAN said, suppose the English Government were to suppress absolutely the trade between India and China, was Mr. Matheson of opinion that a Government so weak would be able to prevent the admission of seven devils worse than the one which was cast out?

Mr. MATHESON said he had thought of that a great deal, and he believed that if the Chinese had the support of England, it would make an immense difference in their action, and they were growing in naval and military power.

The CHAIRMAN asked what support England could give to put down smuggling?

Mr. MATHESON said if we left them perfectly free to do as they liked with their own native opium, and would gradually decrease the production in India, on condition that they would do the same thing, he believed, from what he had heard from Chinese statesmen, that they would be thankful to carry out that policy.

The CHAIRMAN said that was the policy proposed by Sir Rutherford Alcock.

Mr. MATHESON said he advocated such a restriction of the growth as would raise the price in China to such a height that its use would be confined to the higher classes, and the lower classes would be weaned from it. As to other countries coming in, he thought it was utterly impossible. A few years ago it was thought to be folly to attempt to put down the slave trade on the West Coast of Africa, but now it was thoroughly put down there, and there was no reason to suppose that, if England were in earnest, it could not be put down on the East Coast of China. The only countries for the production of opium in any quantity were India and China. He did not think there was anything in the argument that we must follow nature because it produced these things; the earth was under the curse for man's sin, and that might account for many of these things that were so deleterious, but as to which we have to exercise our sense of right or wrong.

Prof. LEONI LEVI suggested the discussion should be adjourned, as there were many points connected with it which had not been touched at all.

The CHAIRMAN thought it would be much better to raise those points substantively on another occasion, and not to mix up together in discussion a number of heterogenous questions. On the whole, he thought the audience would rather thank him for directing the discussion to the points immediately raised by the paper, for if they had gone into all the possible questions which might arise with respect to the use of opium, whether it was more or less injurious than alcohol, and so forth, it would have roamed over so large a field, that no one could have arrived at any sort of conclusion. He would therefore call upon Sir Rutherford Alcock to reply.

Sir RUTHERFORD ALCOCK said the meeting had already had its patience very much taxed, and he would not therefore detain it long. He wished, however, to correct one great misconception, because it affected the character of the English Government. It was still reiterated that they had forced the opium upon the Chinese. He begged them to bear in mind this distinct fact, that we had had three wars with

China, first, in 1842, when we reduced them to perfect submission, and when it was in our power to dictate what terms we pleased. On that occasion there was no clause put into the treaty requiring them to admit opium; it was left to them to deal with it, as it would be left to England to deal with wine or brandy, if what Lord Aberdare had suggested should take place. The second treaty was that of Tientsin, when again the Chinese were reduced to submission without further power of resistance, and again there was not a line in the treaty with regard to the admission of opium; but months afterwards, when the Commissioners were settling the tariff, the Chinese Commissioners were asked, "What about opium?" and they said they would admit it upon a duty. It was their own act—it was not the act of the English Government. The treaty had been signed many months before this, and not a word said about opium, nor were they ever even pressed upon the subject.

The CHAIRMAN asked if the Commissioners had any impression that sooner or later opium would be forced upon them?

Sir RUTHERFORD ALCOCK said he did not know what their impression might be, but his impression was that they were quite conscious of their total inability to prevent smuggling, and therefore thought they had better take the revenue, which had since yielded them £700,000 a year. Then there was a third war occasioned by their treacherously firing on the English Minister, and this time they were so completely prostrated that their capital was taken. They had been utterly defeated, their armies destroyed, and they had not the slightest power of further resistance, and a convention was then made; but did Lord Elgin say that they must admit opium? Not a word. On the contrary, they were left free to put a protective duty, or any tax they pleased upon its transit inland. He contended, therefore, that the British Government had not forced it on them in the sense now insisted upon. It was forced upon them by their own total incapability to keep their coast free from piracy and smugglers, so much so, that until England cleared the seas for them, no honest trade could thrive there. Mr. Richards had done him the honour to refer to what he had said upon previous occasions, and it was a fair matter of argument to attempt to put him in contradiction to himself; but he thought he could show that he had not contradicted himself. When pressed by the Committee of the House of Commons to say at that time if the Chinese were forced to receive our opium, he said, certainly they were forced, because they were forced to carry out a treaty, of which the tariff formed a part by a subsequent arrangement, and they could not break the treaty without a risk of war; but that did not contradict anything he had said since. He said they were forced then; but they were not forced before they placed it on the tariff of duty paying articles.

Mr. MCLAREN said Sir Rutherford Alcock's own words were, "We have forced the Chinese Government to enter into a treaty to allow their subjects to take opium."

Sir RUTHERFORD ALCOCK said certainly, under such circumstances, because it was placed on a tariff, and under regulations, which were, at a later date, mutually agreed upon, and made a part of a treaty; but in that treaty, as signed at Tientsin, there was nothing said about opium, it was put in subsequently by their own act and by their Commissioners in the tariff, as a mode of getting out of the difficulty of smuggling, and collecting a duty. With reference to the other point, that at the Indian Council, and afterwards he urged, in support of a policy he recommended, that he had every reason to believe the Chinese were sincere—he might repeat what he had said in his paper, and answer as an English Prime Minister once answered, when twitted with a difference of opinion, before and after the Treaty of Berlin, that "A good many things have happened since then." In the first place, the whole of the western provinces had not then been covered with native opium. The Emperor had not issued an edict, sanctioning, on the request of Li-Hung-Chang, the issue of licenses to levy a regular duty upon it. They had not then, as had been since done, proposed to buy the monopoly of the whole of the Indian opium we produced, for resale and their own profit and advantage in China. Speaking of the sincerity of the Chinese, no doubt there was a public opinion in China which might be perfectly sincere, as there was in this country about alcholic liquors, where, unfortunately, there was so much intemperance. No doubt there was a great body of public opinion which would support a Government in any possible means for diminishing the evil, but it did not follow that the Government would, therefore, be prepared to adopt any particular measure. As to their sincerity. there was, he believed, a certain amount of sincerity, but they were great writers of moral essays, and liked to pose as being a very moral people. He had quite information enough at that time (in 1869) of what was going on in the western provinces to know that they were growing opium largely, and, therefore, the proposal which he urged on the Indian and British Governments was—assuming that they were perfectly sincere, and that at all events there was a body of public opinion they wished to consult, and for this and other reasons earnestly desired to get some concession to aid them to obtain the control of the trade in opium into their own hands—that the Indian Government should at once say, we will not increase the area of cultivation if you, on your part, will diminish your cultivation until it gets to the same point; and after that, we shall be prepared to consider the possibility, *pari passu*, of diminishing it. That was a test how far they had the will and the power to carry out what they said they were desirous of doing.

The very fact that he made a proposition of that kind showed that whatever sincerity there might be in the background, he had his doubts as to their power or will to carry it out.

The CHAIRMAN then proposed a vote of thanks to Sir Rutherford Alcock, which was carried unanimously.

SEVENTH ORDINARY MEETING.

Wednesday, January 18th, 1882; Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., Member of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Bird, Henry, F.C.S., Southdown-house, near Devonport.
Blythe, W. E., F.C.S., Green-lane, Wavertree, Liverpool.
Christie, James Alexander, F.R.G.S., Plymouth.
Cowtan, Mawer Cowtan, 309, Oxford-street, W.
FitzGerald, Gerald Augustus Robert, 11, Great Queen-street, Westminster, N.
Greenwood, Richard Hargraves, Bankfield, Kendal.
Guy, Albert L., A.R.I.B.A., 195, High-street, Lewisham.
Lundie, John Müller, 6, West-parade, Great Grimsby.

The following Candidates were balloted for and duly elected Members of the Society:—

Ames, Louis, 51, Cadogan-square, S.W.
Basevi, Major C. E., R.A., 40, Upperton-gardens, Eastbourne.
Cox, Frederic John, Ferndene, Sidcup, Kent.
Fearnley, James Baldwin, 65, Carlton-street, Castleford, Yorkshire.
Graves, Edward, 126, King Henry's-road, N.W.
Griggs, William, Elm-house, Hanover-street, Peckham, S.E.
Harvey, Frederick, The Grove, Wandsworth, S.W.
Johnson, Charles Edward, Morven-house, Steele's-road, Haverstock-hill, N.W.
Johnson, Edward H., 57, Holborn-viaduct, E.C.
Richardson, Charles, M.I.C.E., 10, Berkeley-square, Bristol.
Robinson, Hugh Cecil, A.M.I.C.E., 6, Westminster-chambers, S.W.
Seaward, George, Aberdeen-lodge, Worple-road, Wimbledon.
Stacy, Jonathan Sargeant, Olive-cottage, Hatherley-road, Sidcup, Kent.
Ward, Thomas Alfred, 10, Rathbone-street, Canning-town, E.

The paper read was—

BOTANICAL SCIENCE IN ITS RELATION TO ORNAMENTAL ART.

By F. EDWARD HULME, F.L.S., F.S.A.

It has been my lot in life to spend much of my time in the midst of rural scenes. First, as a Londoner spending long vacations in a country home, and now as one of the magistral staff of a big public school that has its home amidst the verdure of the Kennet valley, while the chalk hills lock us in on every side; on one of these we see the outer edge of the grand forest of Savernake, a woodland district that stretches, free to all, for many miles. On the other hand, my tastes have been artistic and archæological, and I have, from boyhood, had two ruling passions, the love of nature, and the love of art. Having then thus trespassed on your good nature, by giving you this slight autobiography, you will readily understand that I am desirous of convincing others that these two distinct tastes are by no means antagonistic. It will be at once conceded that a love of nature is not merely not antagonistic, but is essential to a follower of pictorial, or, as it is often called, fine art.

It is needless, then, to stay to point out that he who would paint the rush and turmoil of the ocean, must himself have felt its grandeur, that the man who would delineate for us some scene of pastoral peace, must himself have felt its sweetness; the painter of the harvest-field must himself have rejoiced in its golden plenteousness before transferring its rich wealth to his canvas; while the man who would charm us with some scene of domestic felicity must have felt the joys of home. One can imagine nothing more irksome than the artists' toil if bereft of the artistic feeling. When, however, we turn to another phase of art, the ornamental or decorative, this love of natural beauty is by no means so evident, and we are at once assailed by arguments on naturalism and conventionalism of treatment and the like. With these we will shortly deal; but may we not pause for a moment to consider whether the lower estimate in which decorative art is held when compared with pictorial, may not in some degree be traced to a healthy feeling in men's minds, that on the whole the representation of God's work, and of the creatures of His hand, is a nobler thing, in all its grand simplicity, than any idealisation, conventionalism, or whatever other name we may give to the introduced human element? The highest form of decoration merges imperceptibly into fine art, and though anyone taking up the design for a book cover, or an engraving of the San Sisto Madonna of Raffaelle, would have no difficulty in apportioning either to their true relationship, it is none the less true that decorative art and fine art are separated by no keen line of division. The noblest works of art are themselves designs, as witness the grand groupings in the Last Supper of Leonardo, and no mere soulless photographic transcripts. We had, indeed, some difficulty in finding a suitable contrast to our fine art illustrations; we at first thought of wall-tiles, but we remembered in time the graceful designs of Moyr Smith, full of quaint mediæval fancy, and we felt that these were in their degree fine art. We then ventured on the idea of Christmas cards; but here, too, the design on many of them deprived us again of the sharp contrast we desired, as not a few of them practically are pictures.

It is needless to thrash out again all the arguments for and against naturalism and conventionalism. Where the highest degree of naturalism would not be felt to be inappropriate, as in some china painting, there need be no qualms of conscience, we imagine, in using it, and the genius of the designer is then shown, both by his artistic power, and also by the steps he takes, by grouping, arrangement, and the like, to suit it to its position. Ordinarily, however, certain restraints will arise, and a more or less degree of conventionalism will be necessary; but that work, we take it, is the finest, which conforms fully to all necessary limitations and drawbacks, and yet most fully gives us therewith a sense of the beauty of nature. These limitations will give us the necessary limits for our guidance. If I, for instance, am given a [full palette of pigments, and am assured a suitable position for my work, I may throw into it all my power, and give to the uttermost of my ability my sense of the glowing beauty of the rose, or the exquisite purity and texture of the lily; but if you tell me that these goods will be produced cheaply, and printed throughout in blue, I feel that I cannot then give you what I would of the rose—that I could not caricature it in fact (for whoever saw a blue rose?), so I give you a floral form so far conventionalised that, while my taste will, I trust, charm your eye, your sense of the proprieties will receive no shock. So, too, if my artistic abilities are at too low an ebb to give you more than an inferior naturalism, I fail again to fill you with a sense of the exquisite beauty of nature; and here again a conventionalism of treatment would have been better. I remember once going over a large pottery works in Staffordshire, and seeing many cups and saucers painted, we were told, by children, for 3d. or 4d. each, and we could only wish that such work was impossible at any price. At the mere memory of them I could only recover my equanimity by feasting my eyes on some delightful specimens of Indian pottery I am so fortunate as to have around my study. Here we have no grotesque mockeries of natural beauty, but a full sense of the limitation imposed by the few colours and the simple treatment necessary, and the results an altogether admirable conventionalism. Where a plant is clearly recognisable, the colouring should be appropriate. A few days ago I saw the design for the back of a playing card, in which the violet was treated naturally, yet its blossoms were bright pink. If the designer wished to convey the idea of a violet, why did he make its petals bright pink? If, on the other hand, he wanted bright pink, why did he take the violet when some half-dozen plants as beautiful, the dog-rose, the campion, and so forth, were equally available? I once heard of an old lady in an æsthetic household, tired, doubtless, of the long disputes over principles, laying down the axiom, "It is not this that's pretty, nor that that's pretty, but its what anyone thinks is pretty that's pretty;" but even her all-embracing latitudinarianism, though it would shield the black teeth of the Papuan, the flat head of the Choctaw, or the crippled feet of the belles of the Celestials, would shrink surely from a deliberately and wantonly bright pink violet! My present purpose, however, is not to defend either one or the other of the two great principles, for there is abundant room for the use of both, and "circumstances," as the copy-books tell us, "alter cases." It is rather to point out the desirability of a more general study of nature on the part of our designers. I cannot conceal from myself or my audience the feeling that the riches, the inexhaustible riches, of nature, afford the designer an opportunity that no study of anthemion, acanthus, or the like, can give, and that the man who has studied and sketched by the road side, or in the meadow, is not only a better renderer of natural forms than the man who is content to draw his inspiration from books, or his own internal consciousness, but that that same knowledge leads to a nobler conventionalism of treatment, too, when his work calls for that treatment; that the man of study and observation is doubly armed, while the man without a well-stored sketch-book is doubly weak; that in any case the work founded on knowledge must be preferable to that of ignorance.

Some of my hearers may here take alarm,

and declare that botany, with its long array of multi-syllabled words, is surely a needless study, but I would venture to say that the efficient designer should be not botanist only, but anatomist, archæologist, and many other things besides, if he is to take a high rank, though he will naturally not require to go so deeply into any of these special studies as those who make them the work of their lives. There must surely be a happy medium somewhere between the total want of study, for example, that prevents a designer drawing the human figure correctly, and that profundity of knowledge of the structure possessed by any of our great surgeons; while a man may be legitimately ignorant, so far as concerns his work, of the stone age or the cave dwellers of remote antiquity, and yet find immense advantage from his knowledge of the details of various styles, of a knowledge of heraldry, and so forth.

The Science and Art Department very wisely require some little knowledge of botany from all the art teachers they train, the questions being framed to bring out not only the knowledge of structure, but to test the candidate's power of applying his knowledge in the direction of art. As I have for some years had the honour of being the examiner, I can readily give some two or three examples of the sort of questions set. "Give five examples of bi-symmetrical flowers;" "Give any details you can of the dandelion—order, genus specific name, structure, where and when found, its economic or artistic value, and any other points that may occur to you respecting it." "Sketch a calyx, a corolla, a leaf, a root, a fruit, and in each case state from what plant you derive your example." "Explain any terms with which you may be familiar, as applied to leaves, descriptive, for example, of their forms, textures, positions on the plant, veining, &c. Illustrate by sketches, and state what plants you use as illustrations." "Draw a square so that one of its diagonals (about 6 inches long) shall be upright. Fill this with a design based on any plant you like, and below it state all you know of the plant—name, structure, previous use in art, &c." I take it that none of my audienee will feel that a designer could be anything but the better for the power of answering such questions as these, and that the student who answered the question, "Give botanical details, habitat, season of flowering, &c., of the following common plants:—pimpernel, sow-thistle, woody nightshade, and avens," by saying, "Being a London student, I have not the opportunity of becoming acquainted with these common plants," placed himself at a disadvantage with his fellows. I do not say was *placed* at a disadvantage, but placed *himself*, for I doubt not that half-an-hour's walk westward from South Kensington would have placed him in possession of examples of all four plants.

Many persons are afraid of science, yet science, after all, only means knowledge, and no one surely need be afraid of that, while the word botany, I need scarcely remind my hearers, is derived from the Greek word for plant. If, then, anyone of my audience who is alarmed at the notion of being set down to study the science of botany, prefers to consider that I am trying to induce him to learn something about the common plants around him, my object will be equally well attained. There is no doubt that botanical studies can be made to look uncommonly dry to the uninitiated, and that some of the terms are of portentous length, but I contend that all the terms that we deem it essential to the designer to know, can readily be mastered. I remember to have seen an excellent little work in which all the facts of plant structure were explained in ordinary language, but this necessitated a great deal of roundabout diction that might have been prevented, had a few technical terms been mastered, and as these terms are found in every other book the student desires to consult, it would seem the wiser policy to brace one's nerves to the requisite tension, and face the difficulty. The most accomplished and tasteful designer, if he super-add some little knowledge of plant structure to his other gifts, will be enabled to add the great charm of truth to the forms of beauty he creates.

Let us now see how far this knowledge may be expected to help us, though indeed I can scarcely hope in the short time at my disposal to do more than indicate some few points to illustrate its claim to our attention.

In the first place, our work will be consistent, and we shall employ together plants that have some natural affinity either of time or place: the ignorant draughtsman not unfrequently places together plants that flower in different seasons, or that are found in quite diverse localities. Anyone would, of course, see that there was something chronologically wrong in a group of snowdrops and poppies, or topographically faulty in a combination of water lilies and wheat; yet, extreme as these cases are, I have seen examples that come rather near them. Of course, here again "circumstantances alter cases," and one would be justified in blending into one whole the entire floral year, as a wreath on the cover of an almanack for example.

In the next place, our forms will be correct instead of false. Conventionalism legitimately sets us free from the necessity of identifying our forms with those of nature, but a natural treatment requires an observance of natural facts. If we desire to use the graceful five-pointed leaves of the ivy we may not add thereto the clustering berries, for these are accompanied by leaves of a wholly different character, nor may we add tendrils to the convolvulus, an error too frequently committed. Further, it will prevent our falling into the error of making our stems grow out from each end, when a little spiral curvature prevents our at once noticing our perversion of natural fact. No natural stem sprouts equally from each end. An example will illustrate the error to which I allude, better than any lengthy verbal explanation. [Figures drawn on the black board.] Having thus far dealt with negatives, and pointed out what a study of natural forms will prevent us doing, let us now consider one or two things which it will aid us to do.

In the first place, the infinity of variety in nature will be reflected in our own work, and instead of the constant repetition of some few forms, beautiful as they may be, the whole realm of nature is outstretched before us either to adopt literally, or to adapt as the nature of our work requires. The Egyptians felt the beauty of natural forms, but give us little beyond the lotus, the papyrus, or the palm leaf; the Greeks, earnest students of nature in its highest branch, the human figure, were content to express the overflowing wealth of floral beauty around them by the graceful acanthus leaf, and more rarely—in their vase decoration, for example—the olive, the ivy, or the vine; the Gothic carvers give a far greater variety, and bring before us the oak, the maple, ivy, buttercup, wild rose, and many other beautiful forms, but even they left much untouched. I may, perhaps, be reminded of the Greek honeysuckle pattern, but the antheminon is rather a testimony to the beauty of a mass of radiating and up-springing masses, instinct with a suggestion of vitality and growth, than a definite suggestion of any one plant, and we can only ourselves regard its occasional resemblance to the buds of the honeysuckle as an accidental, rather than an incidental, result.

As I have just referred to the decorative art of the Egyptians, I may point out for our own warning, that while it is strictly appropriate to adorn the capital of a column with the lotus, it is a grave error of judgment to make the lotus flower itself the capital; and it is only the very conventional nature of the treatment that prevents one at once rebelling against the idea of supporting heavy beams of stone on the delicate petal tips of a water lily. We see the same error, the accessory become principal, in two sketches—the one taken from a drinking cup in the British Museum, and the other, Chinese in its origin, in the fine collection at South Kensington. In this latter the forms are fungoid, and as most people have a firm conviction that every form of fungus, except the mushroom, is rank poison, a farther uncomfortable element may be said to be introduced.

Nature, too, will aid us no less in colour suggestions than in form suggestions. The rich tints of the autumn—the brilliant yellow of the dying maple, the bright crimson of the herb Robert, the variety of browns, yellows, crimsons, in the foliage of the bramble, are all full of suggestions to the designer, while the quaint forms and sombre richness of tint of the sea-weeds are in themselves a grand field still waiting to be worked. Many other good ideas for colour arrangements might be suggested, but my desire is to whet your appetites and send you searching for yourselves, that your own eyes may see the beauty that is in every summer hedgrow rather than to spoil its grace for you by mere cold verbal description on this winter's night.

Things that repeat mechanically and frequently should be conventionalised. It is an insult to the infinite variety of nature to repeat at every few inches the same bunch of roses. Hand-work, on the contrary, may justly be varied, and even if we confine ourselves to our roses, we are able to introduce a sufficient modification in the grouping to prevent the tedious sense of sameness. Perhaps the greatest triumph in this principle of variety in unity and unity in variety is seen in the carvings of Westminster-hall, where we see the favourite badge of Richard II, the white hart, introduced no less than 83 times, and though all are equally consistent with heraldic accuracy, no two of them are exactly counterparts. Though we admire the long row of Corinthian capitals, all as like as two peas (a strictly appropriate simile in a botanical paper), or the stately avenue of sphinxes in front of some grand temple in the valley of the Nile, one cannot help feeling that much individuality has been crushed, and we turn with a feeling of refreshment to the play of fancy seen in all the varied details of some grand old Gothic pile, and breathe a freer air.

Where, in addition to the inevitable necessity of repetition, the exigencies of manufacture, as in weaving, prevent any accurate representation of natural forms, conventionalism should again be resorted to. It may be of very varying type in its departure from nature, but where everything has to be worked in squares and to have outlines like flights of stairs, a fatal bar is placed in the way of adequately representing the graceful beauty of nature. It is surprising to see how near an approximation may sometimes be gained by a clever designer under so painful a limitation, but the struggle is too unequal after all, and can only be at all tolerated when the squares are so small that at a little distance the eye fails to perceive them. In glass painting, all the tints will be flat, there will be no suggestion of light and shade, and the leading forms will require to be strongly outlined; but apart from these two necessary limitations, there is nothing to hinder strict truth of representation. And as the glass painter finds his employment in two principal directions—religious, or the glorification of the Creator, the saints and martyrs of the Church; or heraldic, for the glorification of national or family pride—he should needs be able to draw correctly the lily that his virgins bear, or the palm branch in the hands of the victorious saints of God, as well as indicate beneath heraldic conventionlism his sense that he has some just notion of what a rose, a thistle, or a shamrock are like.

All work done under Mohammedan influence is compulsorily conventional, for the code of Islam forbids the representation of any natural form. Shut out from all contact with nature, their artists devised works of exceeding richness. Yet they owed their charm to the intricacy of their design and the richness of their colouring, and after the first feeling of wonder at complex arrangements, and of pleasure in their scheme of colour is over, we turn from them unsatisfied. Japanese art is now fashionable, and we may but seem to be joining in the general applause, yet how delightfully fresh one at once feels it. We must bear in mind, too, that this popular applause, though in some cases of little or no critical value, springs from the true estimation first expressed by those whose opinions really were worth regarding, and this esteem will remain when the votaries of mere fashion have deserted Japan and all its ways, and raised another idol on the empty throne; for the art of these people is no dead thing, but a vital force, instinct with appreciation of all the beauty and quaintness of nature. Technically, too, these people can draw; they have both the observant and appreciative eye, and the ready hand, no complexity of structure, no sharp foreshortening is shirked by them, and all the beauty that their eyes delight in, their hands transfer unfailingly to paper. If I might delicately hint at such a thing, may it not possibly be that some of our people contend for conventionalism, rather than nature, because, amongst other more avowed reasons, it is a very great deal easier to draw? The designer should not rest content with being "a metropolitan student," knowing nothing of the hedge-rows that surround him at a very short railway ride, but sally forth, note-book in hand, well persuaded that even the roughest sketches made from living nature are a most valuable stock-in-trade. I always impress this point strongly on my own resident studio pupils, budding designers, and all upon whom I can exercise any influence. As examples of the sort of thing I mean, I have here some sheets from our folios. Anyone who will do me the honour to examine them will see that they make no pretensions to finish in the conventional sense of the word, yet I would say for them, that I think they contain all that a designer needs. I have myself, when designing for manufacturers, found the immense advantage of a well-filled drawer of them. In making such sketches, all the salient points should be seized, and as much of the life history of the plant given as possible; one should see the opening bud, the blossom in all the glory of its full expansion, the fruit that follows it. All modifications and varieties in the form of the foliage should be noted, and the way the flowers are arranged on the stem should be given. Very often, too, the sections of either stem or fruit will give admirably suggestive forms, and then these, too, should be carefully added. As examples of stem sections, we may give the *Carex vulpina*, the *Alisma plantago*, and the *Spiræa ulmaria*—a kind of sedge, the great water-plaintain, and the meadow-sweet.

Amongst fruit sections, we may notice the primrose, the snowdrop, the *Vellozia elegans*, and the hemlock. It is evident that many of these natural forms might, with very little modification, suggest ornamental arrangements, either the section of the primrose or the snowdrop, being as they stand, very suggestive of some of the Greek patera forms. The forms of the flowers are no less suggestive, giving us, as they do, many beautiful examples of radiate and symmetrical forms. In most of these forms we find that the symmetry of the whole is produced by the aggregation of a series of parts in themselves symmetrical, while in others, this general symmetry is quaintly produced by means of units in themselves unsymmetrical. The St. John's wort and the periwinkle are good examples of this peculiarity. In other flowers again, as the blossom of the *Pelargonium tortuosum*, or the Chinese lantern plant, the arrangement is only bi-symmetrical.

The inflorescence of the plant, the way in which the flowers are arranged, is another feature that may well be studied by the designer. Some flowers, as the snowdrop, rise singly, and stand alone on the summit of their stalks; others, as in the hyacinth or the foxglove, make a long line of blossoms fringing the stalk that supports them all; others again, as in the flowering rush, form what is termed an umbel, and all spring fan-like from one point, a peculiarly beautiful arrangement for decorative work. The arrangement of the leaves, too, is another feature to be noticed. In many plants, as the laurel and the privet, they grow in pairs. Anyone acquainted with the Greek vase painting, will remember how free a use is made of this arrangement. In many cases, again, as in the ivy, the leaves grow alternately, while in others, as the cleavers or the woodruff, the leaves grow in a ring. I have here some diagrams showing how these arrangements can be applied decoratively by the designer. The forms of leaves vary very considerably in various parts of the same plant, the lower ones being often less richly cut than the upper; the marsh mallow affords us a good illustration of this; while in other plants, as the avens or the buttercup, the reverse is seen.

In many plants too, the earliest or root leaves are of a quite different form to those that succeed them. This fact must be well-known to any one who has ever sown mustard or radishes. The sunflower and sycamore give other good illustrations of this feature, and it is needless to dwell on its decorative value.

The various forms of leaves are so multitudinous that I feel how impossible it is to do any justice to their rich variety in so short a sketching time as is here open to me. Here we have a rough sketch of the leaf of the dandelion, and here we have an ornamental adaptation I have based on it. Some leaves are of this elongated character, and are composed of parts given off from a central line, while others radiate from a single point. The leaves of the ground ivy and the coltsfoot will show how great a variety is possible in forms based on the same plan.

It would be easy, having once descended from the general to the particular, to go on sketching by the hour together various suggestions derived from natural forms; but in any case I could not exhaust the subject, though I might very probably exhaust our audience. Allow me, then, in a few closing words, to commend to all designers the great importance of such a study of nature as I have here indicated. Believe me, the hours so spent are no lost time. Books are often ransacked for illustrations, but the aid they afford is as nothing compared to the sketches one can make with the living plant before one. I am, of course, aware that many see all this as strongly as we do ourselves; but it is to those who have not yet found out all the pleasure and the profits of such a course, I venture to suggest it. The study is in many ways its own great reward. Should I have failed to convince my hearers, the fault is mine and not the cause I plead; though I would fain hope that the fair fame of nature has not too greatly suffered at the hands of her self-appointed spokesman.

DISCUSSION.

Mr. George Wallis said every one who took an interest in this subject was greatly indebted to Mr. Hulme for bringing it before the Society of Arts. It was a subject which had long wanted to be discussed properly, and certainly the illustrations which had been given of the value of the study of plants, through the study of botany, and the advocacy of its application to ornamental design, were such as no one could fail to appreciate. It was one thing to tell people to study nature, and quite another thing to teach them how to do so, with a distinct purpose, and then to apply it to practical use. The ordinary mistake, which had existed for the last forty years, was in taking a pictorial view of ornamental art. Haydon and Rippingille, when advocating schools of design, looked at it from the pictorial point of view. Haydon said to him once, "So you would take a lily, but you would not draw it like a lily." "No;" was his reply, "if I drew a lily, I should draw it like a lily; but if I wanted to make a cup of a lily, I should simply seek to reproduce the form in such a manner that it should stand upright in the material I have to work in." This pictorial point of view of decorative art had continued to prevail more or less all through. The study of geometry, of nature, of botany, in relation to design, had become more or less engrafted on the system of our schools of art, and step by step they had taken a better standing than they formerly did as compared to the Continent; so much so, that the system pursued at South Kensington was a source of astonishment to the French Commissioners in 1862, and still more at the Exhibition of 1868, so that at all events we had made some progress. But they still required to have the difference explained between the pictorial representation of plant forms and the conventional representation. Mr. Hulme had told them that this conventionalism was a matter of dispute between mere imitation and conventionalism of form; but the question really reduced itself to this shape. If he took a lily as the subject of a painted decorative panel, it was perfectly clear that he could make such a representation of it as would not at all offend the eye of an artist; although it would be more or less conventionalised, in order to properly fill up the space allotted to the ornament. But when the same design was taken, as the subject of wood or stone carving, the conventional treatment would become altogether different, or else it would be simply a wood or marble imitation of a lily. Again, in the case of textile fabrics, one mode of treatment must be adopted if the subject were to be printed, and another if it were to be woven. Mr. Hulme had given an illustration of the notching effect produced by weaving, and if this were not attended to by the designer, he would print an imitation of a woven design, or weave an imitation of a printed one; therefore, conventionalisation was required to vary according to the material and mode of manufacture for the purpose for which it was to be applied. Again, in a wall-paper, which probably enabled one to reproduce a lily in a form which brought it nearer to a picture than any other, it must be remembered that the ornament must be produced by a series of blocks, and the design must be conventionalised in order to make it properly decorative. That was his notion of what conventionality ought to be in relation to design; the mere exaggeration of form in one direction or another, or the taking of one portion of a natural object away from its proper surroundings was not conventionalising nature, it was simply taking liberties with it, which no lover of nature would dare to do. As long ago as 1839, he delivered a lecture on the "Principles of Natural Form," which created some interest amongst his friends, and he had been repeatedly asked to work out the idea; but being a loving student of nature, the more he studied nature, and particularly plant form, the more difficult he found it to satisfy himself, not that the theory he held was right, but how far it could be practically applied to the purpose to which he had devoted his life. It was this question of the practical application which had kept him from rushing into print, as he otherwise might have done. When he joined the School of Art at Somerset House in 1841, Mr. Dyce was the director; and one day he designed a cup after the shape of the *Mallope grandiflora*, a species of mallow. Having worked it out step by step from the flower, he showed it to Mr. Dyce, who was much pleased with it, saying it was quite original; and the question then arose how it was to be used. Mr. Dyce recommended him to show it to Mr. Apsley Pellatt, a large glass manufacturer, and he did so. When he took it out of his pocket, it happened to be upside down, and Mr. Pellatt said it would make a very good design for a decanter, and if he would sketch him a design for a stopper to suit it, he would give him £5 for it. That was the origin of the broad-bottomed decanter, of which he had seen many since. This was a practical illustration of how a design should be worked out. There were three main points which must be kept in view. First, What was it for? next, What was the material of which it was to be made? and, third, What was the method by which it was to be made? Unless all these points were considered, it must be a drawing, or an idea, but could not properly be called a design.

Mr. PFOUNDES said he was pleased to hear Japanese art so highly spoken of, and he might remark that, very much the same system as that now advocated had been followed for many generations in Japan. He had brought with him some Japanese sketches, which would illustrate and confirm this statement. The Japanese, it was true, did not dissect plants, but they went to nature, and studied floral sprays, leaves, and flowers as they grew, commencing with the most simple sprays of the willow, consisting merely of curves and lines, and gradually combining them until they produced a most perfect picture. He must say, however, that the bulk of the Japanese decorative ware, of which we saw so much in the shops now, was really not the art which was admired amongst the Japanese themselves. He was very glad to find, on so good authority as that of Mr. Hulme, that the study of nature was being followed in England, and this was more desirable than a mere imitation of Japanese designs. Indeed, he had seen examples, in which some of our eminent artists had produced the most absurd results by following the latter plan; for instance, he had seen a picture hanging in a well-known gallery, in which birds only seen in Japan in winter, were flying about in a garden amongst summer flowers; a Japanese artist was never likely to make such a mistake as that.

Mr. H. CLEMENTS thought there was no question that great advance had been made in art matters since 1851, mainly owing to the fact that now drawing was taught generally, whereas formerly it was only taught to those who were supposed to have a talent for it. The result was that our designers were now superior to those on the Continent. The reader of the paper dwelt on the importance of studying nature, and said, that without that, any high standard in art was impossible. All the great artists had studied nature, and in no other way could success be attained.

The CHAIRMAN, in proposing a vote of thanks to Mr. Hulme, said he could not help expressing his gratification that one who was pleased to acknowledge the benefits he had received from the Science and Art Department during the last twenty years, had had an opportunity of giving the Society so valuable a paper. He did not think there was any part of the teaching of the Science and Art Department more important than that relating to design. They all knew that by its means a great number of artists were being trained throughout the country, but they were also anxious that there should be a large number of designers, and it was only the principles which Mr. Hulme had enunciated with so much clearness and force, which were likely to produce such a body of designers as would enable us to keep ahead of other nations. What had been the cause of our great success at recent Exhibitions? All foreigners, at least, were agreed that it was owing to the influence of the Science and Art Department and schools of design. Within the last few months a large French deputation had come over specially to study the South Kensington system in all its developments, and the means by which it spread a knowledge of art throughout the country. It was his duty occasionally—rather oftener than he liked sometimes—to go about the country on the business of the Department, and he was supposed to be able to address various audiences on art; this was a mistake, but he was able to speak of the experience he had had of the great utility of spreading examples of art broadcast throughout the kingdom, and thereby stimulating the rich manufacturers to devote large sums of money to the foundation of art galleries, which created an interest in art in various manufacturing centres. This system was likely in another ten years to yield far greater fruit than they had yet seen. When he looked at the list of works Mr. Hulme had published since 1868, and saw that his active brain had produced some ten books which had become known to every art student in the United Kingdom, he thought they might consider themselves very fortunate that he had been kind enough to give that Society the benefit of his studies. He had done so in a most graceful and artistic way, and he (the Chairman) was quite sure that he only spoke in the name of the whole meeting in proposing to him a most cordial vote of thanks.

The vote having been carried unanimously,

Mr. HULME briefly acknowledged the compliment. He said he must confess to being somewhat of an enthusiast on this subject; but if, instead of wearying the audience, he had given them any gratification, it was a great pleasure to him.

PENCIL SHARPENER—Mr. B. S. Cohen writes to the effect that the pencil sharpener, described in a recent number of the *Journal*, should not be described as an "apparatus," as it is a small implement of the size of the ordinary pencil sharpener.

Miscellaneous.

GOVERNMENT GRANTS TO VOLUNTARY PUBLIC SCHOOLS.

The following memorandum has been sent by Sir Henry Cole, K.C.B., for insertion in the *Journal*:—

I. Having, as Secretary, for many years superintended the administration of the grants made for Schools and Classes of Science and Art, I beg leave to offer some suggestions, which I think, if adopted, might relieve the anxiety of managers of voluntary schools; especially small schools in rural districts; lest the proposals for the revision of the Code should imperil the financial position of their schools. Such suggestions, if adopted, I believe will give to managers the certainty that they will receive the greater part, if not the whole, of the present average grant of sixteen shillings for each scholar.

II. It has been suggested that the proposals of the new Code fail to recognise the widely different circumstances of the various schools; and that big and little schools ought to be treated alike. The difference between Board Schools and Voluntary Schools, and between Scottish and English and Welsh Schools are so great, that I consider each class ought to have its own rules. My suggestions apply only to English and Welsh Voluntary Schools. These schools received, in the year ending 31st August, 1880, one million five hundred thousand pounds, and more. (Report, 1880, p. 175.)

III. The Report for 1880 gives the following statistics relating to the Voluntary Schools I allude to:—The Church of England supports 11,416 schools or institutions, which obtained a yearly grant on each scholar of 15s. 3½d.; the Wesleyans had 569 schools, which received per scholar 16s. 0½d.; the Roman Catholics had 758 schools, which received per scholar 15s. 3½d.; and the British "Undenominational," and other schools, had 1,438 schools which received an average of 15s. 9¾d. each scholar. Mr. Mundella puts the average now at 16s., and I take this as a standard for my suggestions. This amount assured by good working to all *small* rural schools would greatly comfort them.

IV. It has been shown above that the average Government grant for each scholar exceeded 15s. 9d. a year. In suggesting a scheme for paying Government grants, I assume that the total grant might be 16s., but that there is a possibility of its being advanced, by means of prizes for the good working of the school, to 18s. 6d. (A) I suggest, firstly, that the present attendance payment of 4s. should be assured for the future; (B) secondly, that the present payment of 1s. for discipline and organisation be retained, but with the possibility of rising to 3s. by prizes; (C) that 1s., which might rise to 3s., be granted in respect of school buildings, desks, maps, diagrams, cookery utensils, gymnastic apparatus, &c.; (D) that payments of 1s. for each of five compulsory subjects, in boys' schools, such as reading, writing, arithmetic, needlework in girls' schools, and music; and these, with prizes for special excellence, might raise the payment to 6s.; (E) for specific optional subjects, such as grammar, languages, geography, algebra, mathematics, health, cookery, food, &c., a payment of 1s., to be raised by prizes to 3s., be made for not more than three subjects; (F) and, lastly, that the fees of all schools, in places of small population, should be augmented by the payment of an equivalent sum from Government, the maximum contribution being limited. By these means grants, as between large and small schools, might be equalised.

V. As respects fees, I would remind the present generation of friends to education that thirty years ago the Reverend Richard Dawes, afterwards made Dean of Hereford for his educational success, proved that in King's Somborne School, Hampshire—a strictly agricultural parish, of under 1,200 population —it was possible to make a village school, with only 219 children, averaging 10½ years of age, self-supporting by means of *fees*, without any Government grant at all. For details I refer to the account of King's Somborne School, extracted from the Minutes of the Committee of Council on Education, 1847-8 (p. 4, &c.)

School fees afford a good proof that the education is appreciated by the parents who pay them. This is a consideration of the highest importance to future national education. It was by means of the self-supporting principle that I helped to reform the Schools of Design in 1852, and to establish the Science Schools and Classes in 1857; and I rejoice to find the principle remains strongly advocated in the last edition of the "Science Directory." As respects a grant in proportion to the fees obtained from scholars, it may be observed that the grant would give a wholesome stimulus to managers to look vigilantly after the fees, and it would be especially helpful in small schools; its application might, if desirable, be restricted to *places of small population*.

VI. Of course the grants to Infant Schools would be calculated on a different principle.

VII. The inspection of the schools might be much simplified and improved. If local action, so often advocated by Mr. Mundella, were cordially invited by the Education Department, the results of the school work would be more accurately tested, and the cost, perhaps, even reduced, with careful administration. The principles of examination by means of papers, as successfully practised for Science and Art Classes, and modified *mutatis mutandis*, might be adopted. Localities would abundantly supply temporary inspectors, by employing military officers in the reserve forces, at moderate fees, to report on the state of school buildings, their sanitation, and apparatus of all kinds; also on the discipline, the books showing attendance of scholars and fees paid. Localities would easily find, at moderate fees, competent auditors of singing and of reading aloud. Papers would do all the rest of the examination, under the direct control of the district inspectors and their assistants.

VIII. The summary of the grants suggested by me would be theoretically as follows, per school:—

[Assume as the minimum, to be increased by prizes.]

	s.	d.	s.	d.	
a. For Attendance	*4	0	4	0	stationary in all schools.
b. For discipline	†1	0	1	6	say average.
c. For well-furnished Schools & Apparatus	†1	0	1	6	say average.
d. Compulsory subjects taken at the lowest standard, say all five passed....................	5	0	5	0	say average.
e. Optional subjects, say two taken and passed	2	0	2	6	say average.
f. Fees, say.....................	*3	0	4	0	say.
	16	0	18	6	

* These sums might be reckoned as fixed and certain, and the additions likely.

† Say 1s. 6d.

IX. The maximum grant could always be controlled by the Standards. If the present law is to be kept, and no grant is to exceed 17s. 6d., then the grant of 18s. 6d. if due to any school would be reducible to 17s. 6d.

X. I have full confidence that the District Inspectors, which the Education Department proposes with so much judgment to establish, might so work this plan, that every school might fairly expect to get the present average of 16s. at least.

XI. The Government grant, assignable as I have suggested, would have a direct influence in increasing local efforts to have good buildings and school apparatus, and to increase numbers of scholars and fees. The plan would, I think, be less concentrated than now exists in forcing the intellectual efforts of teachers and scholars. It would be fairer in respect of schools which of necessity may be filled chiefly with children of dull capacity. In schools having capable children, it would be as just as the present system of payments. In conclusion, it appears to me that the administration of the grant would be much simplified, and more satisfactory proofs of general educational efficiency, acccording to the fixed standards would be obtained, by means of a united and harmonious action between the Department and local agency.

HENRY COLE.

Christmas-eve, 1881.

THE OPIUM TRADE.

Mr. James Caird, C.B., F.R.S., has written a letter to *The Times*, on the subject of Sir Rutherford Alcock's paper (see p. 201), in which the following passages occur:—

"The Indian growth, so long as it remains a Government monopoly, is strictly limited in its extent. If the Government gave up the control, the growth would at once rapidly extend, and the evil would become worse. Therefore, to produce the result desired, the Government must not only give up this source of revenue, but forbid its subjects from making the most profitable use of their land; and this for the moral advantage of the Chinese, who are the most astute and practical people on the face of the earth, and who would at once increase their home supply, though they might be obliged to content themselves with an inferior and probably more noxious quality.

"And at whose expense would this be done? Ten millions of revenue must be found from some other source in India. Every one who has examined the subject of Indian finance knows the manifold difficulties which present themselves against any proposition of that kind. And all hope of a reduction and final abolition of the salt tax must then be abandoned. Salt is indispensable to the daily food of the 250 millions of the Indian people. It is capable of unlimited production in India, and is so abundant in some quarters that by the river which falls into the Gulf of Cutch millions of tons are yearly washed away by the sea. The duty is ten times the cost of getting the salt, and with the duty it is then 18 times the price of the article in Cheshire. The duty yields about seven millions. It falls equally on rich and poor, but with special hardship on the poorest. Reckoning it by the consumption of families, and estimating each at five persons—man and wife and three children—it is a tax equal to a fortnight's wages on the average of every head of a family of the working class in India, the 24th of a man's labour being thus appropriated of necessity by the Government. Surely we are bound, by every consideration of humanity and policy, to prefer the interests of our own people in India to an endeavour at their expense to improve the moral condition of the Chinese, who are very capable of taking care of themselves."

FIRES IN THEATRES.

The *Journal de Saint Petersbourg*, of the 7th Dec. (19th) last, calls attention to a work, issued about four years ago, by M. Auguste Felsch, in which he states that up to the date of the issue of his publication 252 cases of destruction of theatres by fire had occurred. According to his calculations, a theatre or concert-hall only lasts on an average of 22 years, and is then destroyed by fire. Of the above-mentioned 252 theatres, 5 were burned before they were opened for performances; and 70 only lasted five years; 38 attained their tenth year; 45 the twentieth; 27 the thirtieth; 12 the fortieth; 20 the fiftieth; 17 the sixtieth; 7 only lasted eighty years; 8 lasted one hundred; and 3 only exceeded that age. Thirty-seven places of amusement were burned twice, eight of the largest theatres three times, and four four times, one, the National Theatre at Washington, five times. Taking each country separately, it appears that there have been 176 theatres burned in America, 68 in England, 63 in France, 49 in Germany, 45 in Italy, 26 in Austro-Hungary, 24 in Russia, and 17 in Spain and Portugal. The number of lives which have been lost has been enormous. From a table showing the number of persons who have been killed or injured at the principal fires, it appears, taking an example here and there, that in the year 1794, at Capo d'Istria, 1,000 people lost their lives; in 1836, at St. Petersburg, 800; in 1845, at Canton, 1,700 were killed, and 1,670 injured; in 1846, at Quebec, 200 killed; in 1872, at Tien Tsin, 600; and in 1877, the latest year for which any figures are given, 400 were killed at Montpellier.

The following letter, on the best means of extinguishing fires in theatres, from Lord Alfred S. Churchill, was printed in the *Morning Post*:—

"Sir,—A few years since there was exhibited in the grounds of the Crystal Palace, some experiments for extinguishing fires in theatres. The method employed was so simple in construction, and so perfectly efficacious in its results, that it may not be amiss, at the present time, to recall attention to it. A large wooden structure, in the form of, and about the size of, a stage, had been erected in the garden; this had been filled with loose planks, and bundles of shavings, and old drop scenes, &c. In the roof of this structure, and immediately above this combustible material, had been arranged a series of iron water-pipes, perforated throughout their whole length by small holes. Fire having been placed to this structure, it was, in a short time, in a strong and powerful blaze. When about half burnt through, a tap was turned, and a complete shower-bath of water fell simultaneously on the whole stage. The effect was very remarkable. In about five minutes, the fire was completely extinguished, and water was seen trickling down the remains of the drop scenes and sides of the structure in all directions. The fire was, in fact, drowned out. Now I believe the effect of immediately saturating with water every portion of a theatre, together with its stage, by similar means, would prove more efficacious than the inject of water by a hose in a particular part. As these perforated pipes should run in every direction throughout the theatre, it would require no fireman, at the risk of his life, to direct the fire hose on to any particular part of the building in flames. What could be easier than to apply these perforated pipes to theatres? They should be laid on in sections, and it should be the especial duty of an attendant to remain close to the taps during the whole performance, and on alarm of fire, to turn on the tap for the particular section in which it may occur."

For diminishing the danger of conflagrations in theatres, Signor Giovanni Abelo Martini recommends the following formulæ for rendering materials non-inflammable in the three different cases below:—

1. Mixture suitable for light tissues:—

	Parts.
Pure sulphate of ammonia	8
Pure carbonate of ammonia	2½
Boracic acid	3
Starch, dextrine or gelatine	2
Water	100

2. Mixture suitable for scenes already painted, timber work, furniture, doors and windows, to be applied like paint with a brush, at a temperature of about 140° Fahr.:—

	Parts.
Hydrochlorate of ammonia	15
Boracic acid	5
Glue	50
Gelatine	1
Water	100

3. Mixture suitable for cloths, ropes, and straw, which should be immersed for 15 or 20 minutes, at a temperature of 212° Fahr., and allowed to dry:—

	Parts.
Hydrochlorate of ammonia	15
Boracic acid	6
Borax	3
Water	100

General Notes.

PARIS FURNITURE EXHIBITION. — An International Exhibition of Furniture, Drawings, and Printing is to be held in Paris, this year, from August 1st to November 15th, under the auspices of M. A. Proust, Minister of the Arts.

PRINTERS' INK FROM COTTON-WASTE. — M. Bastand subjects cotton-waste, in a closed vessel, to the action of bisulphate of carbon, or any other liquid having great affinity for oil, and capable of evaporating at a lower temperature. Bisulphate of carbon is, however, to be preferred on account of its cheapness. It should completely saturate the cotton contained in the vessel, and run off with the oil and grease of the waste into a suitable receptacle, in which the mixture is subjected to the action of heat. The bisulphate of carbon is evaporated and condensed, to be used over again, and the oil and grease serve admirably for printers' ink, while the cotton-waste, deprived of its grease, is as useful as before.

USES OF ASBESTOS.—Asbestos, in the form of a felt or tissue, is said to make a good filtering medium for the chemical laboratory, as it resists the action of corrosive acids, as well as of fire. For the same reason, a pair of gloves woven from this substance is useful for handling acids. A sheet of asbestos card covering the table preserves it, and also prevents the breakage of small glass objects. Asbestos makes excellent porous cells for a galvanic battery; and kneaded with plastic clay, affords a good luting for the stoppers of bottles. Asbetos paint, used to protect objects from fire, has also been lately manufactured.

TURIN EXHIBITION. — The authorities at Turin have decided to follow the example of Milan, and to hold an Exhibition in the course of the present year.

MUSICAL COMPOSITIONS OF THE PRINCE CONSORT.—A complete collection of the musical compositions, sacred and secular, of H.R.H. Prince Consort, has just been published, under the superintendence of Mr. W. G. Cusins, her Majesty's Master of Music, by Messrs. Metzler & Co. It was at first intended to print the work for private circulation, but, in consideration of the interest widely felt in it, the Queen has graciously consented that it shall be published instead.

BEER PRESERVER.—At a recent meeting of the *Société d'Encouragement* of Paris, M. de Luynes drew attention to the air filter of M. Eppé, for preventing the turning of beer. The air making its exit from the blowing fan, is filtered by a thickness of about six inches of cotton-wool or asbestos, being thus deprived, not only of any dust which might simply thicken the beer, but also of all the germs of fermentation which might cause it to turn. It was stated the beer preserves its aroma, and keeps better when the air is filtered.

PATENT-LAW.—The Right Hon. Joseph Chamberlain made the following remarks, on the Amendment of the Patent-law, in a late speech at Birmingham:—"I have pledged myself to bring in a Bill on that subject during the next Session, and I am like Mr. James Lowther, I have a Bill in a box; and it is a Bill which would at all events immensely facilitate the process of applying for a patent, and reduce consideraby the first cost of obtaining a patent; and under those circumstances it would, I am convinced, stimulate invention, promote industry, and above all, it would enable the poor inventor to test the value of his ideas, and to get the advantage of his ingenuity, of which, unfortunately, his poverty too often deprives him."

LILLE EXHIBITION OF INDUSTRIAL ART.—The Mayor of Lille has decided that an International Exhibition of Industrial Art shall be held in the Palais Rameau, of that town, from the 15th March to 1st June, 1882. There are to be five classes of exhibits, as follows:—1. Construction: including ornamental stone, wood, and metal work. 2. Furniture: cabinet-making, bronzes, ceramic ware, glass and crystal, painting on glass, decorative painting and mosaic work. 3. Dyed fabrics: including silk, wool, cotton, hemp, jute, linen, paper, leather, lace embroidery, binding, cordwainery, and damasked cloths 4. Goldsmith's work and jewellery: including electro-metallurgy, art castings, gilding, silvering, and enamelling. 5. Various: engraving, printing, photography, scholastic objects, the original works of artists, compositions for serving as models in industry, &c. Further information may be obtained from the Organising Committee, at the Hôtel de Ville, Lille, France.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

JANUARY 25.—"The Causes and Remedies of Bad Trade." By WALTER R. BROWNE, M.A. Lord REAY will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

JANUARY 31.—"The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By WILLIAM COCHRAN.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

JANUARY 26.—"Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals." By Dr. THUDICHUM.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

FEBRUARY 17.—"The Depreciation of Silver as it affects India." By J. M. MACLEAN.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Second Course will be on "Recent Advances in Photography." By Captain ABNEY, R.E., F.R.S.

LECTURE 1, JANUARY 30.—Introduction. Direct action of light. Action of light and development. Daguerrotype. Phenomena met with in photographic experiments.

LECTURE 2, FEBRUARY 6.—The effect of the spectrum on the different molecular forms of the silver haloids. Practical applications. Sensitisers considered. Sensitiveness of the different salts of silver. Sensitometers considered.

LECTURE 3, FEBRUARY 13.—Dry plate processes. Instantaneous pictures. Instantaneous shutters. Enlargements, direct and otherwise produced. Colour of developed prints. Applications of photography to science.

LECTURE 4, FEBRUARY 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 23...British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. Stannus, "The Artistic Treatment of Constructional Ironwork."

Medical, 11, Chandos-street, W., 8½. p.m.

Asiatic, 22, Albemarle-street, W., 3 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. J. W. Judd, "Are there Coalfields under London?"

Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. 1. Mr. James Motteram, "The Bankrupt Law, with a view to Legislation incoming Session." 2. Mr. Harold Brown, "Bankruptcy and Liquidation."

TUESDAY, JAN. 24...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. G. McKendrick, "The Mechanism of the Senses." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Charles W. Folkard, "The Analysis of Potable Water; with Special Reference to the Determination of Previous Sewage Contamination."

Anthropological Institution, 4, St. Martin's-place, W.C., 8 p.m. Annual Meeting.

Royal Colonial, 15, Strand, W.C., 8 p.m. Mr. J. R. Saunders, "Natal in its relation to South Africa."

WEDNESDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Walter R. Browne, "The Causes and Remedies of Bad Trade."

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. W. Davis, "Fossil Fish-remains from the Armagh Limestone, from the Collection of the Earl of Enniskillen." 2. Prof. R. Owen, "An Extinct Chelonian Reptile (*Notochelys costata*, Owen) from Australia." 3. The late Mr. E. W. Binney, and Mr. James W. Kirkby, "The Upper Beds of the Fifeshire Coal-measures."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, JAN. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Chemical and Physical Section.) T. L. W. Thudichum, M.D., "Recent Researches into the Theory of the Living Contagium, and their application to the Prevention of Certain Diseases in Animals."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. John Radcliff, "The Flute."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. N. Moseley, "Corals." (Lecture II.)

Inventors' Institute, 4 St. Martin's-place, W.C., 8 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Mechanical Engineers, 25 Great George-street, S.W., 7½ p.m. Annual General Meeting. Reading of Papers and Discussion.

FRIDAY, JAN. 27...Royal United Service Institute, Whitehall-yard, 3 p.m. Captain C. O. Browne, "Attack on Ironclads by Artillery."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. R. S. Poole, "The Museum and Libraries of Alexandra."

Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. J. G. Waller, "Sand."

Clinical, 53, Berners-street, W., 8½ p.m.

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Reading of Papers and Discussions continued.

Browning Society, University College, W.C., 8 p.m. 1. Mr. J. Thomson, "Notes on the Genius of Robert Browning." 2. Miss Mary A. Lewis, "Why I like Browning."

SATURDAY, JAN 28...Physical Science Schools, South Kensington, S.W., 3 p.m.

Royal Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Ernest Pauer, "Ludwig Van Beethoven." (Lecture II.)

Physical Society, 3 p.m. 1. Prof. W. Chandler Roberts and Mr. T. Wrightson, "The Fluid Density of Metals." 2. Mr. C. Vernon Boys, "Apparatus for Calculating Efficiency;" and (3) "A New Electric Meter."

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FRIDAY, JANUARY 27, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

The Exhibition of Photographic Appliances, in connexion with Captain Abney's Cantor Lectures on "Recent Advances in Photography," will be opened on the evening of Captain Abney's first lecture, January 30th. The Exhibition will be kept open from January 30th till about the end of February, every day from ten to four, and on Wednesday evenings from six to eight. On Monday evenings the Exhibition will be open to those attending the Cantor Lectures.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

Persons not members of the Society, who are interested in Photography, may obtain tickets on application to the Secretary.

Arrangements have been made for showing the actual working of some of the more recent printing processes, and it is probable that illustrations may be given of photography by various artificial lights.

A catalogue of the exhibits will be published, as a supplement to next week's *Journal*. Copies will also be printed separately, for the use of visitors to the Exhibition.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

CANTOR LECTURES.

SOME OF THE INDUSTRIAL USES OF THE CALCIUM COMPOUNDS.

By Thomas Bolas, F.C.S.

Lecture IV.—Delivered December 11th, 1881

Other calcium compounds and their uses. The phosphorescent sulphide. Lime soaps. Bleaching powder. Phosphates of calcium. The hardness of water, &c.

Very many of the calcium salts possess the property of phosphorescence in a notable degree; that is to say, they absorb light when exposed to its action, and afterwards slowly evolve it in the dark; the secondary or phosphorescent rays being generally of a lower degree of refrangibility than the absorbed rays. Some samples of fluorspar afford a good example of this phosphoresence. Here is some fluorspar which has been exposed to a powerful light, and although the gas is turned down, you cannot see the light which is evolved. If now the fluorspar is warmed by being placed on this piece of heated iron, the phosphorescence will be so far exalted that you will be able distinctly to see the greenish-yellow phosphorescent rays; the effect of heat being very greatly to increase the phosphorescent energy of any substance charged with light.

Chalk, limestone, shells, and plaster of Paris are generally more or less phosphorescent; but although the evolved light is energetic enough to produce a considerable effect on a sensitive photographic plate, it is not powerful enough to be very obvious to the eye, unless special precautions are taken for its observation.

One of the most phosphorescent bodies known at the present time is the sulphide of calcium, a body which may be readily obtained by heating a mixture of lime and sulphur to bright redness, or by heating sulphate of lime with the necessary proportion of carbonaceous matter. The phosphorescence of sulphide of calcium was observed and studied by Canton many years ago; but it is only recently that the highly phosphorescent sulphide of calcium, which is used in the manufacture of Balmain's luminous paint, has been prepared. Here is a bottle of the sulphide of calcium in question, and, now it has been charged with light by exposure to the rays of burning magnesium wire, you see how brilliantly it glows in the dark, evolving sufficient light to enable one to read moderately large type by its rays. If this bottle were preserved in the dark, the evolution of light would continue without intermission for more than a fortnight, but with a continually diminishing intensity, so that to see the powder in the dark at the end of the fortnight, one would have to rest the eyes by remaining for some time in a dark place. Supposing that the bottle were kept in the dark for a considerable period, say six months, the stored-up light would not be quite exhausted, as on warming the bottle by immersion in hot water, a considerable evolution of phosphorescent light would take place.

When made into a paint with a suitable oil-varnish, the sulphide loses none of its phosphorescent properties; and articles which have been painted with the Balmain paint remain distinctly visible during the whole of the night, provided that they have received the light during a portion of the day. This circumstance renders the paint of very great value for such purposes as painting posts or gates in dark lanes, the piers of bridges, boats, carts, hoardings, or other objects which may be the cause of accidents in dark places. More than this; a room which is, in great part, coated with the luminous paint is never dark, provided that it receives the daylight for a few minutes during each twenty-four hours. In such a room, one may always read letters half-an-inch high; and, if no great time has elapsed since daylight was admitted, it is easy to read small type, such as pica. It is also likely to prove of very considerable value for painting the interiors of railway carriages, as the phosphorescent light renders lamps unnecessary when the route consists of alternate daylight and tunnel. In the case of the paint made with oil-varnish, the sulphide is thoroughly protected against decomposition; but when the powder itself is exposed to damp air, it is slowly decomposed, evolving traces of sulphuretted hydrogen.

To give you an idea of the extent with which the phosphorescent paint retains the light, Mr. Barker will hand round a painted card, on which the word "Putney" is inscribed. This card, which has been lent to me by Mr. H. T. Wood, the Secretary of the Society, was exposed in the daylight during this day, and since dusk it has been kept in the dark.

Gas-light serves very well to excite the phosphorescent sulphide, and to illustrate this, let me take a tablet one foot square, which has been hanging behind an ordinary gas-burner. This, when handed round will be found to give quite enough light to enable one to tell the time by a watch; and such a card kept in readiness behind a gas jet, to which it, by the bye, forms a good reflector, might be kept in constant readiness as a safe light for fetching gunpowder, petroleum, or other combustible. The tail end of a train painted with Balmain paint has proved to be even more obvious on a dark night than the usual lamp, and to illustrate this kind of use for the material, Mr, Barker will bring in a wheel which has been painted.

The phosphorescent properties of the sulphide are considerably exalted by the application of heat, it becoming more highly charged while warm, and discharging itself more rapidly. Note the effect of slightly warming this piece of painted canvas, and also notice the curious result obtained when one's hand is placed at the back of the sheet, the heat passing through causing a hand-shaped patch of increased luminosity—in fact, a true thermograph.

Here is another curious experiment. Mr. Barker is sitting in yonder chair, in front of a screen or background painted with the sulphide, and on burning a few inches of magnesium wire a little distance in front, Mr. Barker's shadow is cast on the screen; the shaded portions remaining unexcited, while the general surface becomes luminous. Mr. Barker will now move away, and leave his shadow behind him, like Peter Schlemihl, in Chamisso's well-known story.

Two years ago, when Professor Heaton was lecturing to you on this remarkable substance, it was merely a laboratory product, being manufactured in batches of a few ounces at a time, and at a cost of over twenty shillings per pound; but now it may be regarded as an article of commerce, tons being manfactured now, where pounds were made formerly. There is every reason to hope that, as things progress, the phosphorescent sulphide will be made at as low a price, if not lower, than any other white pigment. The sulphide paint must, naturally, not be laid on the top of any other paint which contains lead, or the black sulphide of lead will be slowly formed. A special neutral base is sold for forming an inert medium between old lead paint and the phosphorescent paint. Through the kindness of Messrs. Ihlee and Horne, of Aldermanbury, each one of you will have the opportunity of taking away a small article painted with the luminous paint. It is said that they have just made arrangements for painting an arch of one of the bridges crossing the Thames.

Another calcium product, which now possesses a considerable commercial importance, and is likely to increase in value, is the blast furnace slag, so long a waste and troublesome bye-product. It may be regarded as a crude glass, consisting of lime and clay, only it requires a somewhat higher temperature for fusion than is the case with ordinary glass; but by fusing a varying proportion of sand and soda with the slag, a more useful product may be obtained. The slag, when broken up, makes a rather poor substitute for granite as a road-making material, and blocks or other articles cast of it require a prolonged annealing in order to be of any practical use. A slag product of very considerable interest and important is the so-called slag-wool, which is obtained by blowing a jet of steam across the liquid slag as it flows from the furnace, the result being a confused mass of fine threads, like wool; but these are intermixed with a greater or less number of minute spheres like small shot.

Slag-wool was first manufactured by the late Mr. Edward Parry, about 40 years ago; but in recent times the manufacture and uses of slag-wool have been considerably extended. One of the most successful works for the production of slag products has been organised by Mr. Charles Wood, who read a paper on this subject before this Society rather more than a year ago.

Samples of Mr. Wood's slag products are before you, these having been kindly supplied by the agents, Messrs. Jones & Co., of Kentishtown. Here are samples of the slag-wool, and models to illustrate its use in clothing steam-pipes so as to confine the heat. It is also largely used in order to protect water-pipes from the destructive influence of frost, and to fill partitions in houses, with the view of deadening sound, or preventing the rapid conduction of heat. Here we have a thick and tolerably flexible felt, built up out of the slag wool, an iron wire network being used to give strength in some instances.

By cooling the molten slag in water it becomes disintegrated, and a kind of sand or shingle, is obtained, both these forming an admirable basis for concretes and cements, these uses being illustrated by specimens on the table. When finely ground, the slag sand possesses properties analogous to those of the puzzolana found in Italy, or the trass, which comes from the Rhine districts; and when mixed with a pure lime, it is rendered hydraulic.

The calcium phosphide is a remarkable compound, and it may be readily obtained by passing the vapour of phosphorus over lime heated to bright redness. Here is some of it, and please observe the effect of dropping a lump into a jar of water. The phosphide of calcium becomes decomposed, and the spontaneously inflammable variety of phosphuretted hydrogen is evolved; this gas taking fire on the surface of the water. This evolution of phosphuretted hydrogen is made available as an indicator, to show the whereabouts of a life-buoy, a small cylinder containing phosphide being attached, and this is perforated or pricked just before the buoy is thrown into the water. In the case of the War Department and Admiralty buoys, the cylinder containing the calcium phosphide is torn open in the act of taking the buoy from its peg. The Board of Trade requires every ship to take one of these buoys bearing a cylinder of phosphide of calcium; but here we find one of those strange circumstances which can only be explained by the general fact of the ways of boards and committees being mysterious and past finding out. *They do not order these buoys to be painted with the phosphorescent paint, although such a buoy would always be visible to those on ship-board, and each flash of the burning phosphuretted hydrogen would exalt its luminosity, and render it increasingly easy for the drowning person to lay hold of it.* The oil or varnish form of the luminous paint withstands the prolonged action of fresh or salt water perfectly. The rough model on the table, consisting of a frame of painted card, with a piece of phosphide of calcium tied in a rag at one corner, illustrates this kind of twofold luminous buoy.

It is usual to attach a cylinder containing the phosphide of calcium to the nose of a fish-torpedo, so that, if the mark is missed, there may be a chance of recovering the torpedo. Here, again, the phosphorescent paint might be brought into play, especially as the means of lighting it up is provided.

It is curious to note how the phosphide of calcium, and the sulphide of calcium, can thus be used side by side for a similar purpose.

The phosphates of calcium have considerable industrial importance, one of these forming the earthy basis of bones. Here is a bone which has been thoroughly burned in yonder gas muffle, and the mineral matter only remains. You see that it is quite white, and retains the external form of the bone. This mineral matter of bones, the so-called bone-earth or bone-ash, consists mainly of the tribasic phosphate of calcium, its composition being

$$Ca_3\ (PO_4)_2.$$

Not only is this bone earth the ordinary source of the important element phosphorus, but it is used for many industrial purposes, as in making certain kinds of porcelain; and my friend, Mr. Emery, of Burslem, tells me that if cremation ever becomes a general practice, he shall take out a patent for working the ashes of deceased relatives, which practically consist of phosphate of lime, into the material of a porcelain vase, instead of keeping them as a loose powder. Soluble superphosphates of calcium are of great value as artificial manures, and are obtained by treating ground bones with oil of vitriol, and they may be regarded as the tribasic phosphate in which more or less of the calcium has been replaced by hydrogen, as in the following examples :—

$$(1.)\ Ca\ H_4\ (PO_4)_2.$$
$$(2.)\ Ca_2\ H_2\ (PO_4)_2.$$

The chloride of calcium is a waste product in numerous manufacturing operations, and notwithstanding that numerous uses have been found for it, the supply is in excess of the demand. It has a remarkable tendency to absorb water from the air, and is consequently largely used in the laboratory for drying air and other gases; and it was proposed at one time to water the streets with a solution of this salt, as, under these circumstances the roads would remain constantly damp; but this brilliant idea came to nothing, as foot passengers naturally objected to a system which would keep their boots in a chronic state of dampness.

Chloride of calcium crystallises with six molecules of water, forming crystals, which produce a considerable degree of cold when dissolved in water, and a still greater cold when mixed with snow or powdered ice.

The so-called chloride of lime, or bleaching powder, is largely manufactured by passing damp chlorine over powdered lime. You may consider that it contains a large amount of chlorine locked up ready for action, the release being readily effected by any free acid. This is well illustrated by the process of discharge printing. Here is a piece of madder-dyed cotton cloth, and Mr. Barker will stamp on it some devices with a mixture of gum and tartaric acid. It is next immersed in this bath, which contains chloride of lime and water, and in a few minutes you will find that a thorough bleaching of the red colour has been effected where the mixed acid and gum were printed on, the general groundwork of colour being unchanged. Either chlorine, or the still more energetic hypochlorous acid, has been liberated on those parts of the fabric which were impregnated with the tartaric acid.

The hardness of water depends on the presence of lime salts, the so-called temporary hardness arising from the presence of carbonate of lime dissolved in carbonic acid; while the so-called permanent hardness is due to other salts of lime. Temporary hardness may be readily removed by the addition of sufficient lime to unite with the excess of carbonic acid, or by boiling; while more complex measures are required to remove soluble compounds of lime in other forms. It was my intention to show you the method of testing water for hardness by means of a solution of soap, and give you some further particulars regarding hardness of water, but time will not admit of it. It will, however, interest you to see a very ingenious apparatus, by which the dirty soft water which flows from roofs during the earlier period of a rain storm, can be led into a drain, or allowed to run to waste, while the clean after-flow is automatically shunted into a fresh channel, This apparatus, know as Buck's rain-water percolater, has been kindly lent by Mr. Roberts, of Haslemere, Surrey. The advantages of a constant supply of clean, soft water, for drinking and other domestic purposes, are sufficiently known to all; but one precaution is necessary. Lead pipes, pumps, or fittings, must be avoided, as soft water acts readily on this poisonous metal, and dissolves a portion as oxide, while ordinary hard water fails to act on it to a dangerous extent.

As might be expected in a short course of lectures on the calcium compounds, the things which have been left out exceed in number and importance those which have been considered. The uniform and uninterrupted success of the experimental illustrations has depended, in great measure, on the watchful care which Mr. Barker has exercised over all the appliances used; and your best thanks, as mine, are due to him in this regard.

EIGHTH ORDINARY MEETING.

Wednesday, January 25th, 1882; Lord REAY, Vice-President of the Society, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Birch, Cecil, 32, Newton-road, Bayswater, W.
Cristopher, George, F.C.S., 8, Rectory-grove, Clapham, S.W.
Hilles, Malcolm W., 138, Finborough-road, S.W.
Irvine, Thomas W., 6, Aubrey-road, Holland-park, W., and 10, Austin Friars, E.C.
Jackson, Col. R. Rainsford, Ashurst, Sydenham, S.E.
Mewburn, William, Wykeham-park, Banbury.
Paynter, Lindley William, M.I.C.E., 15, Windsor-road, Ealing, W.
Pennell, George Brice, M.I.C.E., 2, Heavitree-park, Exeter.
Rees, William Andrew, 7, Cornhill, E.C.
Smith, Charles William, Westmoreland-mills, Lamb's-passage, Chiswell-street, E.C., and 33, Highbury-hill, N.
Sohn, Charles, jun., 311, Camden-road, N.
Welman, Major Charles C., The Priory, Prior-park, Bath.

The following Candidates were balloted for and duly elected Members of the Society:—

Ainslie, Oliver Alexander, F.R.Hist.Soc., 48, Lincoln's-inn-fields, W.C.
Birkbeck, Edward, M.P., Horstead-hall, Norwich.
Brereton, Cuthbert Arthur, M.I.C.E., 23, Delahay-street, S.W.
Brind, Alfred Walter, M.I.C.E., East Preston, near Worthing.
Burch, Nathaniel Geach, Brunswick-house, Dartmouth-park, Forest-hill, S.E.
Carmichael, David, Ward Foundry, Dundee.
Carter, E. Harold, F.S.S., 33, Waterloo-street, Birmingham.
Common, Andrew Ainslie, F.R.A.S., 63, Eaton-rise, Ealing, W.
Cook, Arthur Stanton, 14, Furnival's-inn, E.C.
Cooke, William Henry, Lea Bank, Coppice, Oldham.
Cropper, Samuel, 28, Budge-row, Cannon-street, E.C.
Crossley, Richard, Bentcliffe-house, Accrington.
Cust, Robert Needham, F.R.G.S., 64, St. George's-square, S.W.
Dadson, Albert William, 6, Raymond-buildings, Gray's-inn, W.C.
Dowson, Joseph Emerson, A.M.I.C.E., M.I.M.E., 3, Great Queen-street, Westminster, S.W.
Fell, John, Augusta-place, Leamington.
Fyfe, John, 9, Grosvenor-terrace, Glasgow, and Young's Parraffin Light and Mineral Oil Company, 7, West George-street, Glasgow.
Henderson, Ridley, 9, Bush-lane, Tottenham Court road, W.
Holthouse, Carsten, 15, Percy-st., Tottenham-court-road, W.
Jones, Thomas John, 12, Princes-street, Hanover-square, W.
Kingzett, Charles T., F.C.S., F.I.C., 17, Lansdowne-road, Tottenham.
Ladd, John Haskins, 116, Queen Victoria-street, E.C.
Leonard, Hugh, 7, Hanover-square, W.
Lloyd, Robert Samuel, 84, Upper Whitecross-st., E.C.
Macdonald, Colonel R. M., 80, Oxford-gardens, North Kensington, W.
Moll, Frederick Henry Ludwig Raphael, 18, Old Broad-street, E.C.
Radford, Francis, 26, Pembridge-gardens, W.
Russell, Joseph, Glenclune, Port Glasgow.
Schram, Otto, 49, Wood-street, Woolwich, S.E.
Scott, Edward Lionel, Salters'-hall, St. Swithin's-lane, E.C.
Simpson, James Carrington, M.I.C.E., Broadway-chambers, Westminster, S.W.
Speck, Thomas Samuel, M.I.C.E., 8, Eaton-rise, Ealing, W.
Wallis, George Ambrose, M.I.C.E., 14, Sea-side-road, Eastbourne.
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The paper read was—

ON THE CAUSES AND REMEDIES OF BAD TRADE.

BY WALTER R. BROWNE, M.A., M.Inst.C.E.

The object of the present paper is to investigate the agencies which promote or hinder the commercial and manufacturing prosperity of this country; in other words, to inquire what are the causes of good or bad times. It is not my intention to trace the chain of causation very far, but rather to dwell on the proximate or immediate causes: these are generally the only ones which we can in any way influence, whether as individuals or as a State; and if so, the only ones of which the elucidation has much practical value. The best course of proceeding appears to be: (1) to state what, in my opinion, is the main cause of fluctuations in trade; (2) to sketch briefly the grounds on which this opinion is founded; (3) to describe the other causes which have been alleged for the same facts, and to show how far they fail in accounting for them; (4) to consider the practical consequences which flow from the theory.

First, then, the proposition which I seek to establish is the following:—"Trade is good when much money is being spent on *new* industrial enterprises; trade is bad when little money is being spent on such enterprises."

It may be well to spend a few words in explaining what this statement really means. It will be observed that the whole stress is laid on the word *new*. Of course, at all times a very large amount of work is required to supply the everyday wants of the world—*i.e.*, to find food, clothing, and other necessaries for the population; to supply fuel for manufactories, railways, and steamers; and to meet other established wants. But our statement asserts that these are not sufficient to keep the industries of such a country as England actively engaged; that the capital and labour embarked in these industries must be employed, in great measure, on new enterprises, if it is to be fully employed at all. Throughout this paper the chief illustration will be drawn from the case of railways, with which, in point of fact, almost all the great fluctuations in trade for the last fifty years have been connected. It may, therefore, be said, as an illustration, that unless new railways are being somewhere constructed, with plant supplied by England, the railway plant trade of England will be in a state of severe depression.

The direct evidence for this theory may be cast under three heads:—

(A.) The general experience of those engaged in trade, especially manufacturers. *(B.)* Statistics of the immense requirements of a new enterprise, as compared with one already in working order. *(C.)* The history of trade for the last fifty years, as affected by the development of new industrial enterprises.

(A.) The general experience of manufacturers will, I believe, agree with my own—viz., that by far the greater part of the really valuable orders, which keep a business going, have their source in new enterprises of some kind, or at least in new extensions of old ones. Of course there are always hand-to-mouth orders given to supply daily requirements, and these are by no means to be despised; but it is not these which give that rush of work which makes a trade really brisk and prosperous. To take our previous illustration, it is when a new railway is being constructed in a district that the purveyors of railway plant and material look for a prosperous time. Or again, it is when a town is being largely increased, that the brick-makers, timber-merchants, &c., of a neighbourhood find their profits increased also.

(B.) The enormous difference between the amount of money needed to set an enterprise at work, and to keep it at work, is not perhaps generally appreciated. It is, however, something like the difference between capital and interest. Let us take again the case of a railway. It will be conceded that, after a railway is opened, the first important part which will require renewal is the permanent way. Yet even this has a comparatively long life, and, moreover, this life is continually being increased, as improvements are made in the durability of the materials. The sleepers, being of wood, are generally the first to fail; but their life has of late years been immensely increased by the process of pickling in creosote or some other antiseptic. Very careful investigations on the German railways have shown that sleepers, if pickled, last from 15 to 20 years, instead of 5 to 10 years as formerly. With regard to the rails, a somewhat similar change has been introduced by the substitution of steel for iron. The result has been that, in the United States, the consumption of rails in maintenance largely decreased from 1872 to 1878, although the mileage opened largely increased during the same period. In the last two years the case has altered, no doubt because prosperity has caused many lines to take the opportunity of changing iron rails for steel; but even in 1880 the total did not reach that of 1872. The following table, extracted from the *Railroad Gazette*, shows roughly the consumption of rails in the United States, from 1872 to 1880, both in maintenance and construction:—

CONSUMPTION OF RAILS.

Year.	Total.	In construction	In maintenance.	Total laid Jan. 1.	Per cent. renewed in year.
	Tons.	Tons.	Tons.	Tons.	
1872	1,530,850	740,500	790,350	7,671,500	10.30
1873	1,148,849	392,000	758,849	8,412,000	9·02
1874	837,695	192,000	645,995	8,804,000	7·34
1875	810,770	151,000	659,770	9,096,000	7·33
1876	879,916	231,000	648,916	9,141,000	7·10
1877	764,744	206,000	558,744	9,378,000	5·95
1878	882,695	360,000	522,700	9,584,000	5·54
1879	1,157,420	440,000	717,420	9,941,000	7·22
1880	1,674,235	688,000	986,235	10,384,000	9·50

This table not only shows the great and increasing durability of the rails, but also the large proportion of rails used in construction, even where the existing mileage is so enormous as in the United States. Moreover, it is certain that the tonnage allowed for maintenance is too large, because it includes a great quantity of rails used for small extensions on existing lines, without being separated from the general amount ordered for maintenance. These should properly be taken from maintenance and added to construction. On the whole, it would appear that the average life of rails in the United States is now from 15 to 20 years. But, as already mentioned, the permanent way of a railway is the least durable item of its plant, except, perhaps, the wheel-tires and other working parts of the rolling-stock. It would thus appear safe to consider that if a railway has required, say, £1,000,000 worth of railway plant during construction, it will be at least twenty years before it has required another £1,000,000 worth for renewals. A similar statement would hold good, it is believed, in the case of every other description of plant.

(C.) Thirdly, we have to show that the modern history of trade confirms the view that prosperity depends on the promotion of new enterprises. The investigation of this question is rendered difficult by the extreme scantiness of the materials. It is surprising that there should exist nothing like a history even of British trade and manufactures, taken as a whole. The work which comes nearest to it is, of course, Tooke's "History of Prices," but this deals almost exclusively with corn, and is written throughout to support a particular view. The following sketch, however, has been mainly compiled by its aid, and by that of the chronological supplement to Mr. W. G. Fossick's "Chart of the Iron Trade."

It is needless to go back beyond the era of Waterloo, since during the French war English trade was in a wholly abnormal condition. I commence, therefore, with the year 1816. With the establishment of peace it was supposed there would come a vast demand on the Continent for English goods; and, in consequence, large quantities were exported on speculation. We have here, therefore, the first instance of the development of fresh enterprise; but it was an unfortunate one. The people of Europe were too poor to buy; English goods became a drug; and the make and the wages dropped accordingly. With this cessation of enterprise came a series of bad harvests, which in those days meant a great rise in the price of bread; and the distress throughout the country was consequently severe. It was not removed by the better harvests of 1820-22, in 1822 a special Commission on agricultural distress was nominated; but the improved policy of Mr. Huskisson, and a large increase in the exports, produced a gradual improvement in trade. In 1824 things were in a sound and satisfactory condition; and in that year the era of railways, so fruitful in commercial results, may be said to have opened, by the proposal of lines from Liverpool to Manchester, Liverpool to Birmingham, and London to Birmingham. But, in 1825, the South American States were recognised as independent; and an exaggerated belief in their mineral wealth led to an enormous investment of British capital in South American mines. Foreign loans also became, for the first time, prominent objects of speculation. But the mines bubble burst almost immediately; the capital lent abroad was not forthcoming for payments at home; and the severe crisis of December, 1825, was the result.

From this the recovery was very slow, the depression of trade lasting till 1834. Meanwhile, however, the construction of railways was commenced, though at first on a small scale. The Liverpool and Manchester line was opened in 1830, and the immense cheapening of transport by the new system was gradually recognised, together with the corresponding opening for large profits to the proprietors. The growing prosperity was aided by the large increase of exports, and by the facilities offered by joint-stock banks. In 1835 the first railway mania began, and, in 1836, the price of Staffordshire bar-iron had risen to £11 5s. per ton. How much of this speculation was due to railways is shown by the fact that out of £105,000,000 nominal capital of joint-stock companies, formed in 1834-36, nearly £70,000,000 was for railways alone. At the same time the construction of railways began in the United States. But in 1837 a severe financial crisis occurred in that country, and re-acting on England, produced a similar effect here. Staffordshire bars fell at Michaelmas, 1837, to £7; but the recovery was rapid, and, in 1839, they stood throughout the year at £9 15s., and this in spite of the financial tightness, which caused the Bank rate to be advanced to an unprecedented figure. The years following this witnessed the commercial reforms of Sir Robert Peel; but in spite of the facilities thus given to trade, in spite of an abundant harvest in 1842, and in spite of exceedingly low rates for money, prices declined steadily, until at the end of 1843 iron reached perhaps the lowest point it had ever known. The recovery of 1844 was marked and rapid, and it exactly coincided with the beginning of the second railway mania, which culminated in 1845.

In 1846 came the potato famine in Ireland, and at the same time the free trade agitation at home. In 1847, the enormous prices to which railway stock had risen began to fall. Calls could not be met, and a financial panic took place in April, and also in October, notwithstanding a good harvest in the autumn. The great effect of railway enterprise may be judged from the fact that the total amount paid up for railway capital had risen from £88,000,000 in 1845 to £200,000,000 in 1848. At the end of 1848 the price of Staffordshire marked bars was £6 10s.; at the beginning of 1849 there was an abrupt rise to £8, apparently due to the excitement produced by the discovery of gold in California. But by the end of 1849, the price had fallen again to £6, at which it remained until the autumn of 1852. In spite of these low prices, trade was in a satisfactory state. The amount of iron exported rose steadily, the exports advancing from 709,492 tons in 1849, to 1,261,272 in 1853. In this last year there was an abrupt rise in prices, although money was dearer, and corn also, the harvest being a bad one; but at the same time the shipments to the United States had increased by 43 per cent. 1854 and 1855 were the feverish years of the Crimean war; and prices continued high, with rapid fluctuations. At the same time the commencement of railways in India took place; and in 1856 there was a large increase of exports and a good trade. This continued till November, 1857, when the effects of the Indian Mutiny and of the Commercial Crisis in America produced a severe financial panic, and drove the Bank-rate to 10 per cent. Nevertheless, heavy orders for rails from Russia prevented the fall either in prices or exports, as related to iron, from being a severe one. A period of fairly steady trade and increasing prosperity followed tlll 1863, when the operation of the Limited Liabilities Acts produced a great extension of business, much of it speculative and unsound. 1864 and 1865 were years of active but feverish trade. In 1866 came the great commercial panic which was inaugurated by the fall of Overend, Gurney and Co. Prices fell sharply, though not to a very low point, and then remained at about the same level till 1870, in spite of a good harvest in 1868. In 1870 railway building was active on the Continent, and in 1871 began an extraordinary extension of the railway system in the United States, stimulated by certain Acts of Congress passed to facilitate the construction of Western lines. In the same year the price of steel rails, which had been £17 10s. in 1864, fell to the unheard of figure of £10, so that the difference between their price and that of iron rails was only £2 10s. Hence the conviction that steel was the proper material for rails, and a corresponding demand on the steel rail-makers. But these were few, especially in America. Hence the demand, both there and in England, greatly exceeded the supply, and the price rose by leaps and bounds until, at Michaelmas in 1872, it had reached the old figure of £17 10s. All descriptions of iron and steel followed the lead thus given; coal, as usual, followed iron, and every kind of manufacture and produce followed iron and coal. By September, 1873, an enormous amount of American capital was locked up in unfinished or hopelessly unproductive railways. The result was a financial panic of the severest character. In England, where the capital was yet free, no such crash followed; but the cessation of all demand from America produced a heavy falling off of exports, and a gradual decline, not only in prices, but also in the amount of business done. Especially was this noticeable in steel rails, which, in 1879, fell to the unheard-of figure of £4 10s. per ton, barely one fourth of the price they had commanded six years before. There can be no doubt, that from the autumn of 1874 to that of 1879 were the worst five years the modern trade of England has ever known. There was a steady decrease in trade from 1872 to 1876, and nothing that can be called a recovery until the unexpected start in 1879. The reasons for this sudden revival are now well known. Under the influence of a succession of good harvests, trade in America steadily improved, and another large extension of western lines took place. The demand for iron and steel exceeded the capacity of the American works and furnaces, and overflowed to this country. The result was a rapid rise in the price of these articles, followed by a decided improvement in prices of all descriptions. But it is now admitted that there was never much real recovery of English trade as a whole. The profits were made only by the sellers of raw material, not by the manufacturers of finished goods. Consequently, when in the beginning of 1880 the American demand suddenly slackened, prices of all sorts fell as rapidly as they had risen, and approached once more the level of the late disastrous years.

One most discouraging fact remains to be noticed. It will be seen that in previous trade crises, the effect on the quantities of iron and steel exported has been very small. After 1866, 1847, and 1837, there was actually a steady rise in the quantity exported. In 1855 there was a slight fall, but there was an immediate recovery in 1856 to more than the level of any previous year. But from 1872, when the exports of iron and steel attained their highest limit, there was a heavy and regular decline till 1876. A slight rise took place in 1877, followed by another slight decline in 1878; and though there was a marked rise in 1879, it did not reach the level of 1873, much less of 1872. The latter has indeed been exceeded in 1880, but the immense

COMPARATIVE TABLE OF THE FLUCTUATIONS OF THE IRON TRADE, BANK RATE, HARVESTS, AND RAILWAY ENTERPRISE, 1830-1880.

Year.	(1.) Exports of iron and steel from United Kingdom.	(2.) Make of pig iron in United Kingdom.	(3.) Price of Staffordshire marked bars.	(4.) Price of steel rails.	(5.) Bank rate.	(6.) Wheat produced in United Kingdom.	(7) Yield per acre in United Kingdom.	(8.) Miles of railway opened in United Kingdom.	(9.) Miles of railway opened in United States.
	Tons.	Tons.	5s. per ton.	5s. per ton.	Per cent.	Quarters.	Bushels.	Miles.	Miles.
1830...	117,135	678,417	116	...	...	...	...	Authorised. 55	23
1831...	123,776	...	142	...	...	...	...	61	72
1832...	147,541	.	114	...	...	...	...	226	134
1833...	162,812	...	116	...	...	...	...	128	151
1834...	158,166	...	157	...	...	...	...	186	253
1835...	199,005	...	137	...	...	...	...	989	465
1836...	192,855	828,931	197	...	...	...	...	362	175
1837...	194,290	817,430	221	...	...	...	...	49	224
1838...	256,015	...	175	...	...	...	...	43	416
1839...	247,909	1,248,781	180	...	...	...	...	...	389
1840...	268,266	1,396,400	190	...	...	...	...	...	516
1841...	360,875	...	185	...	...	...	...	...	717
1842...	369,898	...	142	...	...	...	...	...	491
1843...	448,925	...	132	...	...	...	...	...	159
1844...	458,745	...	120	...	...	...	...	204	192
1845...	351,978	...	150	...	3	...	...	296	256
			(Mids. 240)						
1846...	433,335	...	200	...	3¾	...	...	606	297
1847...	549,709	1,989,608	190	...	5	...	...	803	668
1848...	626,142	...	185	...	3¾	...	...	1,182	398
			(Xmas. 130)	...					
1849...	709,492	...	160	...	3	...	...	869	1,369
1850...	783,423	...	140	...	2½	...	...	625	1,656
1851...	919,479	...	120	...	3	...	...	269	1,961
1852...	1,035,884	2,701,000	120	...	2	11,575,000	22⅞	446	1,926
1853...	1,261,272	...	160	...	3½	10,466,000	20⅞	350	2,452
			(Jan. 220)						
1854...	1,196,863	3,069,838	200	...	5	17,563,000	34¾	367	1,360
1855...	1,092,735	3,218,154	220	...	4¾	13,923,000	27⅜	282	1,654
1856...	1,438,900	3,586,377	180	...	5¾	14,193,000	27	375	3,647
1857...	1,532,386	3,659,407	180	...	6¾	17,321,000	33⅛	329	2,647
1858 ..	1,349,058	3,456,064	180	...	3¼	16,310,000	31½	503	2,465
1859...	1,465,191	3,712,804	150	...	2¾	13,135,000	26⅛	460	1,821
1860...	1,442,045	3,826,752	150	...	4¾	11,079,000	22⅛	431	1,846
1861...	1,359,309	3,713,380	150	...	5¼	12,272,000	25¼	432	651
1862...	1,567,283	3,943,463	140	...	2½	13,958,000	29¼	686	834
1863...	1,702,573	4,510,040	140	...	4½	17,922,000	38¾	771	1,050
1864...	1,558,930	4,767,951	170	350	7½	16,216,000	35¼	467	
			(Mids. 190)		4½				738
1865...	1,687,071	4,819,254	170	340		13,976,000	30⅝	500	1,177
1866...	1,762,485	4,523,897	170	310	7 (10 for 3 months)	11,485,000	25⅛	565	1,742
1867...	1,968,026	4,761,023	170	280	2½	9,567,000	21	393	2,449
1868...	2,041,852	4,970,206	150	260	2¼	16,733,000	34	381	2,979
1869...	2,675,331	5,446,757	140	240	3¼	13,419,000	27	(?) 249	4,615
1870...	2,825,575	5,963,515	160	210	3	14,151,000	30	(?) 249	6,070
				(Mids. 200)					
1871...	3,169,219	6,627,179	160	227	3¼	11,457,000	24	250	7,379
1872...	3,382,762	6,741,929	180	235	4½	11,519,000	24	438	5,878
			(Mids. 320)						
1873...	2,957,314	6,566,451	240	340	4¾	10,323,000	22½	268	4,107
			(Mids. 320)	(Mich. 350)					
1874...	2,487,162	5,941,408	280	320	3¾	13,973,000	29¼	367	2,105
1875...	2,457,308	6,365,462	220	215	3¼	10,018,000	22⅞	209	1,712
1876...	2,224,470	6,555,997	200	175	2⅔	9,733,000	25	214	2,712
1877...	2,346,370	6,608,664	180	143	3	10,971,000	26½	205	2,339
1878...	2,296,360	6,300,000	170	132	3¾	12,647,000	30	256	2,694
1879...	2,879,894	5,995,000	150	115	2⅜	5,905,000	15½	363	4,721
				(Mids. 90)					
1880...	3,787,271	7,200,000	160	170	2¾	9,114,000	26	287	7,200

Columns (1) to (4) are taken from Fossick's "Chart of the Iron Trade."
" (5) Paterson's paper, Statistical Society, 1880, p. 26.
" (6) and (7) Lawes and Gilbert's paper, Statistical Society, 1880, p. 330.
" (8) Board of Trade Returns, and Bradshaw's "Railway Journal."
" (9) Poor's "Railway Manual," 1881.

expansion in that year has not been maintained, the total exports, 1881, showing but a slight increase, while those to the United States have fallen off considerably. This feature, unprecedented in English trade, cannot but excite very great apprehensions as to its future. This part of the subject is illustrated by the comparative table on the preceding page.

We have now to consider shortly the other causes which have been commonly alleged for trade fluctuations. These may be practically divided into two classes. According to one school the matter is entirely one of finance; and the state of the currency and the value of the precious metals somehow influence and decide the whole problem. Another school finds the solution in the position of the food supply, and holds that good and bad times are entirely a question of good and bad harvests. To this latter school must be added the physical speculators, who have tried to connect the crises of trade with the periodical changes in the number of spots on the sun.

As to both these causes, I do not, of course, presume to say that they have no bearing, or no considerable bearing on the subject; but that they are the only causes, or even that they are the most direct and important causes, is negatived, I believe, both by theoretical considerations and by the facts of statistics. The latter is sufficiently shown by the sketch of history already given, and by the figures on which it is based. To take one or two salient examples, money was never, perhaps, so cheap as in the disastrous years of 1875 to 1878. The banks were encumbered with vast sums of money on deposit, on which they paid 1 per cent. interest at the most; and yet it was impossible to revive any single branch of industry. In fact it is notorious, that to obtain money for any new commercial enterprise is very much easier when money is scarce than when it is plentiful; a truth which cannot be questioned, although it seems difficult to reconcile with the principles on which political economy is based. Again, the revival of trade in 1879 took place during a succession of some of the worst English harvests ever known; and two good harvests in 1847 and 1849 were unable to undo the effect of the crisis in 1847. The general improvement in 1881, in spite of bad harvests almost all over the world, is the latest and perhaps the best instance of this truth.

On the general considerations connected with these two causes, I can only touch lightly.

The first theory, that of the currency, arises mainly, in my opinion, from a confusion of cause and effect. The commercial life of England does not in reality centre in the Royal Exchange. Fluctuations in business do, no doubt, have considerable effect on the state of the currency; but the fluctuations of the currency have comparatively little effect upon the state of business. Let us take an extreme case, and suppose a gang of thieves were to sweep off at one stroke all the bullion in the Bank of England. What would be the result? The disturbance in the currency would be frightful, and there would be a heavy fall in the funds. But any ordinary manufacturer or merchant, doing a safe business, would read the account in his morning paper with very much of his usual equanimity. His own credit, and that of everyone of his customers, would be just where it was; cheques and bills would be honoured or dishonoured as before; orders would be just as plentiful or just as scanty; and the only consequences to which he would look forward with apprehension would be some probable inconvenience in paying his wages, and a more than probable addition to his income-tax. In short, if one man has goods to sell and another has goods to buy, they will not be prevented from concluding their bargain by any difficulties as to the arrangements for making the payment. The same may be said of the much vexed question of the balance of imports and exports; which, however important, does not affect, at least, the immediate prosperity of a country.

For the second alleged cause much more is to be said. An abundant harvest must, of course, increase the wealth of a country, taking that word in its proper sense of the things which are to be bought, and not of the mere circulating medium that buys them; and increased wealth must *have a tendency* to produce increased activity in enterprise and speculation. But what I maintain is, that good harvests are not the direct and immediate cause of good trade; they can only be ranked as one among many remote causes. In fact, it is easy to see that the effect of harvests will be complicated by more than one circumstance. Thus a bad harvest in England will doubtless have some effect in slackening the demand for home consumption; but this may be counterbalanced or outweighed by an increased demand from abroad, as we have seen it to be in 1880. Again, in the United States, where almost everybody has a taste for speculation, and abundance of money in farmers'

Pockets is pretty sure to "fructify," sooner or later, in commercial enterprise of some kind, a good harvest will generally produce improvement in trade. But the same would not hold of other countries, such as France, where the harvest is reaped by peasants, whose favourite investment for their gains is a share in the national "rentes," or, more probably still, the toe of an old stocking. Finally, whatever degree of influence we may be disposed to ascribe to a bad harvest, it must be remembered that it is an evil altogether beyond our remedy, at present even beyond our calculation; and therefore that our attention may more profitably be directed to other causes, which are to some extent amenable to practical treatment.

I here conclude, for the present, the proof of the principle which I have advocated, and go on to consider the practical deductions which will flow from it, supposing it to be granted. The first of these may be stated as follows :—"That a country should always encourage, by all means in its power, the carrying out of new industrial enterprises, in all cases where these do not involve an actual waste of the capital invested in them." Since, according to our principle, briskness of trade depends upon activity in new enterprise, the inference is obvious, that the carrying out of such enterprises is in itself a thing to be encouraged. The qualification is no less obvious. To spend money upon piers that fall into the sea, mills that are always idle for want of work, railways that lie silent and grass-grown, cannot be a wise step, whatever immediate appearance of prosperity it may give. But I wish to urge, and that most strongly, that by capital wasted, I do not mean capital that returns no adequate interest to the investor, or even, necessarily, capital that returns no interest at all. In recent times an idea seems to have grown up that no money should ever be spent, unless it is sure to produce a direct return of something like 5 per cent. per annum. Of all economic fallacies this is probably the most mischievous. Had it been always acted upon, we should have no roads, no public buildings, no docks, no canals; for in all these cases, and hundreds of others, the direct return has come very slowly, or has never come at all. For a private person to act on this principle would be considered madness. What should we say of a nobleman who had a house in the middle of a large park, and refused to make a road up to it, because he could not levy tolls enough to pay interest on its construction? The following case is precisely similar, except that it is more strong. A few years ago there was declared to be urgent need of a railway, to connect the city of Madras with the hill country inland. It was admitted that a large goods and passenger traffic was waiting for the railway; every Government official, and every other person consulted, reported strongly in its favour; and an enterprising contractor undertook to find the money and make the line, if the Government would guarantee an interest of 4 per cent. upon a portion only of the capital. The guarantee was refused.

The whole history of railways is an exemplification of what I urge. In England they were looked upon, from the first, purely as commercial speculations; speculations which Government would just permit to exist, provided they were fenced round with a sufficient network of costly restrictions. The result has confessedly been that the capital account of English railways is higher by some hundreds of millions than the amount that was really required for their construction, and the country is so much the poorer for ever. In Belgium, on the other hand, a railway was considered in its true light as an improved road; and in consequence the charges for conveyance on Belgian railways are only a fraction of those which hold in this country.

The fallacy of this modern doctrine is yet more apparent in the light shed upon it by the present argument; for, whether an enterprise is in itself a financial success or not, it would at least have a direct and immediate effect in stimulating trade; so that, even if the capital expended on it be absolutely wasted, it is not impossible that it may, on the whole, do nearly as much good as harm to the prosperity of the country.

Our second practical deduction is :—"That the time which should be chosen for encouraging new enterprise should be when trade is bad, and not when it is good." This is so obvious that it needs little argument. An enterprise begun when times are bad and prices low, will at once be constructed more cheaply in itself, and also will mitigate, to some extent, the severity of the depression—perhaps even prepare a return to prosperity. But, though obvious, the remark is none the less needed. As a matter of fact, it is always far easier to obtain facilities and support of all kinds for a speculative enterprise when things are at their highest, than when they are at the lowest.

A third deduction will be the following :—

"That the kind of enterprise which it is desirable to foster is that which tends to cheapen production directly, and not indirectly." An example will make this clear. If a city or a district wishes to cheapen the cost of its coal, it may do so in two ways. It may either spend capital in opening up new coal pits, in order to diminish the price by increasing the competition; or it may spend capital in extending railways, and so cheapening its cost of transport. Our principle asserts that the second method is in all cases the proper one to employ. The cheapening effect of increased competition is uncertain, and if advantageous to the consumer, is often ruinous to the producer; or else ends in a combination amongst the producers, which retains prices at an artificially high level. The same applies to manufacturing works of all descriptions. England, at this moment, is almost a graveyard of manufactories, which, having been started at great expense, now lie dead for lack of employment; and nothing would probably give much more advantage than an Act which should prohibit the starting of new works of any description for, say, 15 years to come.

Our fourth and last deduction is of a still more important character. If prosperity depends on the development of a new and sound industrial enterprise, then a country like England cannot prosper unless she has a share in the development somewhere of such enterprises. But as regards herself, it may well be questioned whether much remains to be done of this character. If we classify the wants of men according to their urgency, they may be perhaps stated as follows: (1) food, (2) clothing, (3) shelter, (4) protection, (5) tools, (6) conveyance. Now, with regard to most of these headings, it is obvious that, in a country like England, but little in the way of new enterprise is possible. Her inhabitants are amply supplied with food, with clothing, and with protection. With regard to shelter, something no doubt remains to be done in the way of improved dwellings for the poorer classes: and from this point of view the Industrial Dwellings Act may be looked upon as one of the most important measures of our generation. But for the last 50 years new enterprise has chiefly been directed to the cheapening of conveyance, notably by the opening of railways. It is obvious, however, that as more and more railways are built, fewer remain to build, and in point of fact the rate of increase in miles open has lately shown a very great diminution.* Between 1854 and 1862 the increase in miles open was 3,498; between 1862 and 1870 it was 3,986; but between 1870 and 1878 it was 1,796 only, or less than one half the average of the two preceding periods of eight years. This fact is sufficient in itself to account for the continuous depression in all trades connected with railway building. It may be said, that if England is supplied sufficiently with the means of conveyance, the rest of the world is not. But the days when English firms supplied the men and materials for building foreign railways have practically come to an end, at least as concerns the Continent, and also in great measure the United States. These countries now do their own work for themselves, and, even when Englishmen could do it more cheaply, they are almost always excluded by heavy protective duties. From this point of view, it would certainly seem that the forebodings of those who declare that England's prosperity is a thing of the past, are sufficiently justified. If prosperity depends upon the development of new industrial enterprise, if in England industrial enterprise has received nearly its full development already, and if England is shut out from contributing to its development in other countries, then it must follow that the prosperity of England is doomed permanently to decline. I must confess that this view appears to me to call for the most serious attention on the part of all Englishmen. There is, however, in my opinion, one door of escape, and one only. At the present moment, when we speak of England, we do not mean only the country so named on the map; we include, at any rate, Scotland and Ireland in our idea. If we may only go further — if we may also include British North America, British South Africa, Australia, and New Zealand, in our conception of England, then the case is wholly altered. It is not England, but only a small fraction of England, which is an old and densely-peopled country, and whose manufacturing prosperity is on the wane; by far the greater part consists of young and vigorous lands, requiring for their development only men and capital, that is, only what the old country is precisely fitted to supply.

It will be seen that what I am here concerned to urge is, that England and her colonies should be encouraged by all possible means to draw themselves together into a union, as firm and stable as that which subsists among the inhabitants of a single country. If this could once be established, colonists would feel that to put duties on English imports was as monstrous as it would be for England to tax the productions of Scotland; and, on the other hand, Englishmen would feel towards colonists precisely the same cordiality and regard as towards those born in the United Kingdom. It would seem as unreasonable to leave the Cape Colony without railways, as to leave a growing district of Yorkshire without them. It is absurd to say that distances are too great for this to be possible. Distance is only important so far as it means loss of time in communicating; and modern science has reduced this loss to insignificance. It may safely be predicted, that within a short time it will be possible to reach America in a week and Australia in a month*; whilst at the present moment, the telegraph keeps all three countries in constant and instantaneous communication. Thus Australia and London are, to all intents and purposes, far more nearly connected than were Edinburgh and London one hundred years ago. In this closer union between the colonies and the mother country—a policy advocated by so many able men, especially by Sir Arthur Helps and Mr. Froude—I see the one hope for the continuance of England's material prosperity. The opposite course of turning the colonies adrift to shift for themselves, whether injurious or not to them, would be simply suicide to us.

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* Proc. Inst. C.E., vol. 60, p. 8.

DISCUSSION.

Mr. Liggins objected that the paper dealt almost entirely with railways as the cause of good trade, and he could not agree with the conclusions at which the writer had arrived. His father was the originator of the Southampton docks, which were not commenced until after the main lines of railway had been completed, and they and other docks had contributed very largely to the development of the trade of the country. Therefore it was quite a mistake to say that the trade of the country was bad simply because railways were not being made. The discovery of gold in California and Australia took place after the commencement of the railway period, and that was a great factor in the progress of England. A West Indian steamboat had just arrived, bringing the paltry amount of £53,000 in gold, whereas, twenty years ago, he had come over more than once in a steamer having over a million on board. It was the gold put into manufactures which made the prosperity of England, and enabled her to supply the markets of the world with goods at cheaper prices and of better quality than any other country could then do. The effect was noticeable even in artistic circles, for he remembered when Sir Martin Archer Shee thought himself well paid with 300 guineas for a picture such as an artist would now charge two or three thousand guineas for, because so many manufacturers had made immense fortunes, which they had expended in art as well as in manufactures. During the last few years, everyone admitted that trade had been bad, and he anticipated it would be much worse. It was painful to see the empty ship-yards down the banks of the Thames; and he read, in the *Times* of the 16th inst., that even the American export trade to Europe was almost stagnant, grain being carried at such low freights that some ships had left New York in ballast to seek freight elsewhere. That was the cause of bad trade—the disarrangement caused by disorganisation and losses made in this country. He considered a great deal of it was due to the continual tampering with duties by the Chancellor of the Exchequer. Some time ago he laid out £5,000 in machinery, on the strength of a budget speech, and a year or two years afterwards it was rendered useless by an alteration made in the mode of levying the sugar duties. A similar tampering with the wine duties was now going on. He was a sharer in one of the largest steamship companies, and for three half-years he had received no dividends; and the Messageries Maritimes were now bringing goods here from Lyons and elsewhere, and going away in ballast. This sort of thing had a material influence on the Exchanges. The *Times* and other papers dared not give the exports of bullion; they gave the figures once last year, but they were so frightful, that they were never repeated.

Mr. Martin Wood said they always appeared in the *Economist*.

Mr. Liggins said he was not interested in the *Economist*, and therefore did not read it. The sugar growers in the West Indies were now sending their sugar to the United States, in preference to England, where they came in competition with French, Belgian, Dutch and German sugars; and the English owners of these estates were now deriving their income from the United States. He knew a case in which a merchant in the City, whose firm had been established 100 years, was selling his ships, and investing in American ships, for taking the produce of the West Indies to New York. Another friend of his, at the head of one of the largest firms in Liverpool, had also sold his ships, and he (Mr. Liggins) was selling his own also. He could also speak as a member of the Assessment Committee of the parish of Kensington, as to the great distress which existed amongst the noblemen and merchants who lived in that quarter, numbers of them coming before the committee for a lowering of their assessments. In his opinion, the only cure was to introduce a system of fair trade, in place of free trade. This country became rich under the old-fashioned system of protection to native industry, and the working-men of England were becoming awake to the fact that it must be re-introduced. He did not mind being called a fool, for he was supported in his opinion by all the Continental nations, and by the United States.

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* The latter prediction has already been realised, since these words were originally written.

Mr. B. FRANCIS COBB agreed with the last speaker that the paper dealt too exclusively with the iron and railway industries. The proposition put forth that trade was good when money was being spent on new industrial enterprises was true, to a certain extent, but a large portion of the trade of the country, including all the textiles, was excluded from the calculations on which the paper was based. Even as regarded rails, he could not entirely follow Mr. Browne; it was certainly not the experience of this country, that when a million had been spent on the construction of a railway, it would be twenty years before a renewal was required, and he doubted whether it was according to the experience of any other country. The reader of the paper had entirely lost sight of the enormous business which had sprung up of late years in this country in the manufacture of telegraph wires and cables, which was not all affected by the price of railway iron. He gave as a reason for the sudden revival of the iron trade in America in 1879, the succession of good harvests, which was no doubt the case; the increase in the western railways being a consequence of the agricultural prosperity of the country. It was a result, not a cause. He had referred to the banks having large sums of money at command from 1875 to 1878, and only paying 1 per cent., and said it was impossible at that time to revive any branch of industry; but he (Mr. Cobb) thought he could name several, in particular, steam-ship building, which made most rapid strides during that time, and had continued to do so up to the present. Another manufacture which had been begun, and was making great progress, was the utilisation of waste silk, both here and in France. It was a most astounding statement, that a robbery of all the gold in the Bank of England would not cause a disturbance of trade. Such an occurrence would send a shock, not only throughout this country, but to the furthest corner of the world. The dismal forebodings that the prosperity of this country was past could hardly be reconciled with the revenue returns which had been issued year after year, showing the amount of exports and imports. One would really suppose, from some expressions, that this country was going to the dogs as fast as it could, whereas, as a matter of fact, business was sound, and we could stand by almost unmoved and watch the financial panic in Paris, and even assist by exporting gold without raising the bank rates. Mr. Browne had proposed certain remedies, but had omitted to say how they could be carried out. It was all very well to say there should be a railway here or there; but was the Government to make them? Such a thing would not be tolerated for a moment in England. Where there was a fair prospect for a railway, commercial enterprise would provide it. An instance had been given of the Madras railway, but the reluctance of the Government to advance money on guarantee interest on that undertaking at the time, might be partly explained by the fact that it had just been expending large sums on canals in Madras, both for the purposes of transport and irrigation, in order to prevent the recurrence of famines. Another reason probably was, that in the southern part of India railways were largely made by private enterprise. No one could be a stronger advocate than himself for drawing the colonies as close as possible to the mother country, but the moment any attempt was made to put pressure on the colonies in that direction, they would assert their independence, and they would say they had a right to tax themselves how they liked. If England attempted to deal with them as she once did with the United States of America, the probability was that exactly the same result would follow, only much quicker, and the object in view would be entirely defeated. What we should try to do was so to intertwine our interests with theirs, that they could not get away. In the first instance, trade always followed the flag, and it only left it when it could do better elsewhere. Some time ago, in that room, he drew the attention of watch and clock-makers to the fact that when Englishmen first went to the Cape, they took English watches and clocks, and continued to do so, until our makers allowed themselves to be beaten out of the field by Swiss and American makers, who provided them with a rough, but tolerably good article, which just suited their wants, but which Englishmen would not take the trouble to make.

Mr. MARTIN WOOD thought it might be said, in defence of the treatment of railways in the paper, that they were taken merely as an illustration; and the principle which was laid down, that new industries should be encouraged, was perfectly general. The only qualification given to it was that the capital should not be wasted; but that was almost explained away when the so-called economical principle, that nothing should be undertaken which would not show a profit of 5 per cent., was denounced. He would suggest that profit was the only criterion, roughly speaking, as to whether an enterprise should be undertaken or not. He regretted that more allusion had not been made to India, when speaking of the colonies, though an illustration had been taken from it. He might give another illustration, of a line which was proposed from the Malabar coast to the fertile land of the Ghauts; which had been sanctioned by the local authorities, but was vetoed by the Secretary of State in 1872. Since then, the famines of 1877-8 had occurred; and if the railway had been made in the intervening years, thousands of human lives, many more bullocks, and an amount of money which would have made the railway several times over, would have been saved. The least they might expect would be that the Government should not throw unnecessary obstacles in the way of such enterprises. He had his own opinion as to the way in which public enterprises could best be carried out in India; but there, at any rate, was enormous scope for the application of British capital and skill. One cause of bad trade which, in his opinion, exceeded all others, was the enormous waste of capital in military armaments. It was computed that the national debts of Europe amounted to 3,815 millions, or adding various other items, 5,000 millions, the interest of which, at 5 per cent., amounted to 250 millions per annum; if to this were added the yearly cost of maintenance, the total could not be less than 300 millions, a large proportion of which was an entirely unnecessary waste of human industry.

Mr. MANUEL having had considerable experience in mercantile affairs, said he must quite concede what had been urged, that enterprise *per se* was a very useful element in commercial life. He would, however, draw attention to the fact, that following on the railway mania of 1845, there was a tremendous collapse. The enterprise which was wanted was a sound, well-considered enterprise; what was so disastrous was that there were a number of clever men in the City called promoters, who composed very attractive prospectuses, which they distributed broadcast amongst the inexperienced, offering the most impossible profits on all sorts of impossible schemes for making money. He was not in favour of invoking the aid of the State in business matters, but he thought it would be a step in the right direction if there were some Government office to which prospectuses should be submitted before they were issued. Electric lighting was a matter in which capital might be well invested, and even though it might not prove very profitable at first, it could not fail to benefit the community. The explanation of the apparent anomaly that money could not easily be obtained when it was cheap, was that such was always a time following a collapse, when people were frightened. They gradually became reassured, and more ready to lend, and concurrently with that there was more demand for money, and the rate rose. Nothing could be more fallacious than to state that the commerce of the country would go on much as usual if the gold in the Bank were stolen. The whole commerce in the country was based on the bullion in the Bank of England, and the mere withdrawal of three or four hundred thousand pounds had sometimes been enough to cause uneasiness, and raise the bank rate 5 or 6 per cent. If all the gold were removed, unless the Government stepped in, there would be universal ruin and disaster. He agreed with what had been said about the colonies, and he also agreed with Mr. Cobbe, that it was no use to approach them in any coercive spirit. Colonists looked after their own interests like other people, and they thought, as infant communities, they could do better by protection than by free trade. He believed they were wrong, but he would leave them to find that out by experience.

Mr. STEPHEN BOURNE said he would not take up time by dealing with the illustrations given in the paper, but would apply himself to what he considered the erroneous economical principle on which it was based. Trade might be apparently very good when money was being spent on new industrial enterprises, but it was then often in a very bad condition. The mistake seemed to be in supposing that trade was good because money was flying about; and that trade might be made by the use of money, without any reference to the necessity for that use on the objects to which it was to be applied. The true maxim, in his opinion was, that trade must follow the wants of the consumers; it must not be made simply for the purpose of giving employment, or of putting money into the pockets of those who had it not. The illustration given of the prosperity during the railway mania was, in fact, an illustration of the badness of trade. Money was flying about, and the people became rich; but after all, the wealth of the country was being wasted, and population was bred and retained in the country beyond the means of being supplied with profitable labour. The real cause of badness of trade was that production had outstripped consumption. We had been producing more than our own people had been able to absorb, or than other nations were able to purchase from us. It was said that competition had led to deterioration in quality, which had much affected our markets. The desire to cheapen produce had led to the retention in England of a large number of the population, who would have been much better employed in the colonies in producing the food and clothes they needed, rather than in fighting each other at home in competition for supplying the markets of the world. There was no doubt that thousands of miles of railway had been made at an expense which could have been saved had it not been for carrying out the principle which Mr. Browne advocated, that of making trade. He had just been speaking at another meeting, where he had dealt with what he believed the greatest cause of bad trade, and that was the enormous expenditure on intoxicating drinks, and the conversion of what the Almighty had given us for food into that which only ministered to the passions, and encouraged all kinds of useless expenditure. He thought Mr. Browne was right in refusing to attribute bad trade to financial causes; it was not finance which made good trade, though it often fostered unsound enterprises. He said the revival of trade in 1879 took place during a succession of some of the worst harvests ever known; and that was true. He (Mr. Bourne) was in Sheffield when trade began to revive, in 1879, and he then hazarded the opinion that the orders coming from America for iron were the direct results of the bad harvests in England. This was thought to be a paradox, but he still believed it to be correct. The Americans, by the sale of their corn, were able to purchase our iron. But what was the immediate cause of the revival? The depression had been so great, and prices were so low, that Americans could afford to buy from us, notwithstanding their heavy duties; and their expectation of the amount of corn we should require being inflated, they were induced to lay down railways for bringing that corn to the coast, and thus a fictitious rise in trade was produced for a time. The true remedy was not to embark in new enterprises in England, but to promote the prosperity of the colonies. Why should England be dependent on other foreign countries, when she had in the colonies abundance of the finest soil and the most magnificent climate at her disposal, only wanting labour and capital to produce food and raw material for clothing; where labourers could increase and multiply much faster than they could possibly do in the dens and alleys of our crowded cities. The reader of the paper had also alluded to the vexed question of the balance of exports and imports, and started the astonishing idea that this did not affect the immediate prosperity of the country. He (Mr. Bourne) did not see how the question could possibly be unimportant. It was a much debated question what the true meaning of the balance was, but he thought all economists were agreed that it was a matter of the greatest importance that we should not be obliged to have our obligations from other nations paid off by their sending us the food we required to eat. He believed that had been the case for a long series of years; that we had been calling in our debts in the shape of food and then eating it. That might be true or not, but it could not be unimportant. Taking the four propositions at the close of the paper, he submitted, with regard to the first, that if the word "good" were substituted for the word "new," it would be more correct, and the last part of the sentence might then be omitted. As to the second, the time for encouraging new enterprises was when they were wanted. The development of the electric light was an important matter, but it was unsound reasoning to say it should be undertaken because there was plenty of money lying idle. Thirdly, as to cheapening production, directly or indirectly, it mattered little which it was, and very often the indirect method was most effectual. For instance, it was better to cheapen food by improving means of transit, than by devoting capital to the cultivation of poor soils at home. The whole thing must depend on its innate merits, and the circumstances of the case. Lastly, it was said that England could not prosper unless she had a share in the development of these enterprises all over the world. But England had abundant scope in her colonies, and he believed it would be found far cheaper to transport labourers there, than support them in idleness here in the workhouses, or employ them unproductively. One of the great evils of this country was that we had too many non-producers. A large proportion of the time and talent of the country was employed in scrambling for the possession of that which was produced, rather than in adding to the wealth of the country and of the world by production of something useful.

Mr. WALTER PEALL said it was his good fortune to help many of his countrymen to one of the English colonies, and he knew something about them. When hostile tariffs were spoken of, he would remind them that young countries did their best to build up their industries, as England formerly did, but there was no such thing as a tariff hostile to England in any British colony. In the colonies they did not go in for any claptrap of fair trade or free trade, but for a paying trade, which should help them to prosper as a community. He then quoted a number of figures showing the exports and imports, from which he drew the conclusion that England must be living to a considerable extent on her capital; and if this were so, it must be one of the causes of bad trade. The colonists of Great Britain were, as a rule, very well able to take care of themselves, but there was a strong sentiment uniting them to their friends and relatives at home, as well as one of loyalty to the Queen. One reason why English manufacturers lost some of the markets was because they stuck obstinately to old styles, and would not adapt themselves to the wants of the colonists. In South Africa, they imported ten ploughs from America to one from England, for no other reason than that the former were better suited to the market.

Mr. HARRIS said Mr. Browne had certainly spoken mainly of the iron trade, but he had given it as an example of the general trade of the country. He wished we could have more intimate relations with the colonies; for we had a far better demand from them than from America, and we should encourage the trade with them in every possible way. In India we had the regulation of the tariff, and it seemed unfair that Australia should be able to raise a revenue by a tariff while India could not do so. As a large merchant, who benefited by free trade, he felt that we ought to make some difference between our colonies and those countries such as America, which imposed heavy duties on our manufacturers. He feared that the agricultural interest was being ruined by cheap imports. We had had four very bad crops, and lower prices than for good crops. This was all to his interest, because the worse the crops at home the more he had to import, but the country was going to the bad; and if we had enormous crops, where would all the American supply go? He did not think a duty on American produce would increase the price of food in England, because India was rapidly increasing her growth of wheat. During the last twelve months she had shipped 4,000,000 quarters, and in a year or two he had no doubt there would be 10,000,000, because the natives did not eat wheat themselves. The transit was perhaps 6s. per quarter more than from America, but the cost of labour was at least that much less. Australia, also, was quite capable of shipping 2,000,000 quarters yearly, and with a little further development, could do a great deal more. He thought there ought to be a federation made between this country and all her colonies willing to enter it, with whom there should be perfect trade, though those which could show a necessity for protective tariffs should have a certain number of years allowed in which to abolish them. Then we should be able to deal with the rest of the world. He was quite certain that the real property of this country, which the real test, was decreasing, and it showed we were becoming impoverished. We had enormous wealth to lose, and could go on for many years; but we ought to look where we were going, and see what could be done.

Mr. WILLIAM BOTLY, in reference to a statement about a robbery of the gold in the Bank of England, said he remembered in the year 1825 or 1826, how 115 banks stopped payment, and the effect of that was most disastrous, both to agriculture and commerce, throughout the country. He agreed with what had been said about the colonies, but he found that those Australian colonies which had adopted free trade, were far more prosperous than those which relied on protective duties. At this time of day it was too late to talk of protection, which was an exploded fallacy. As to the loss in real property, he knew a farm which was formerly let at £190 a year, and was now producing, without any expenditure on the part of the owner, nearly £500; and he could not believe, therefore, that landed property was so depressed as some persons reported it.

Mr. LIGHT said there was one point of some importance with regard to the improvement of trade and manufactures which had not been noticed, viz., technical education. From a considerable knowledge of the continent, he was convinced that a great deal might be done in this direction in England.

Mr. CLEMENTS said he found that from 1820 downwards, there had been on an average three good harvests to seven bad ones. A great deal more could be done in agriculture, if tenants had security for their improvements, if so much of the profits were not eaten up by middle men, and if the land were more devoted to other crops instead of wheat.

Mr. PFOUNDES, referring especially to the Eastern trade, with which he was personally acquainted, and which had not increased as it ought to have done, said it was still conducted too much on the old merchant prince system. He had made the statement before, and been taken to task for it, but he must repeat it. The English merchants in the East did not do their own business, they employed natives, and in that way they could never compete successfully with the Germans and other foreigners, who had trading consuls. Our own officials were men of education, who were debarred from trade, whereas nearly all other countries had trading consuls, who used their position to advance the interests of their own trade. Young men should be educated for foreign trade, the same as they were for the diplomatic service; and there should be an institution in London where merchants could obtain young men competent to fill positions of trust abroad, and send home trustworthy market reports. He had brought this subject before the Lord Mayor, and found a great many people who agreed with him; but it needed men of influence to take it up and carry it through.

Mr. BROWNE, in reply, said he must content himself at that late hour with thanking those who had supported him, and deal simply with the objections. With regard to the prominence given to iron and railway matters, it was simply because the iron trade was always affected by activity in any other branch, which could not be said of any other trade. He was not a railway engineer, but he had served his time as a dock engineer, and had no desire to treat docks lightly, but no one could say that they were of equal importance with railways in cheapening transport. The cost of transit was now, on an average, 1d. per ton, whereas it was formerly 1s., which of itself showed what enormous advantages the trade of the country must have derived from them. He would have taken figures showing the general trade of the country if he could, but they were not accessible. It had been said that you must judge of the civilisation of a country by the amount of sulphuric acid it consumed, and there was some truth in that; but he thought it could be judged better by the quantity of pig-iron used. He understood Mr. Liggins to attribute the prosperity of the country since 1845, entirely to the gold discoveries; others put it down to free trade; and someone else might say it was owing to the potato famine which occurred about the same time; but any such suggestions were negatived by the figures in the table on the wall. They showed that the prosperity of the country, as exhibited in the growth of the iron trade, had begun ten years before the gold discoveries, and gradually went on, with fluctuations, until it culminated in 1872. Mr. Cobbe's remarks rather corroborated what he had said; there was no doubt renewals had been more rapid during the last few years on account of the substitution of steel rails for iron. Steamship building, since 1876, had no doubt been the one exception to the prevailing depression. As to the robbery of the money in the Bank of England, he put it as an extreme case; but he still maintained that a manufacturer doing a sound business would not be much affected by it. Of course, to those who were doing a speculative, unsound business, and had a large quantity of doubtful bills, such an event would cause great uneasiness; but if the result were to sweep away all such bills, he should be glad if it took place to-morrow. The Government would never allow the Bank to stop payment, even if it could not weather the storm by its own resources; and the instance given of a large number of banks throughout the country stopping simultaneously had no sort of analogy to it. He considered the view put forward by Mr. Bourne most fallacious, that no enterprise should be undertaken which would not show a profit. The instance of the Indian railway given by Mr. Martin Wood showed that an undertaking might be profitable, although it did not show a commercial profit at the commencement; would any one say that it would not have paid well to make the railway, and save all those people's lives, even if the railway did not pay its working expenses? Was there a single railway ever made which had not paid its cost over and over again in improving the property of the adjoining landowners? He could not agree with Mr. Wood, that the profit on a concern was even a rough criterion of its value, and would refer again to the case of the Indian railway. He had not referred to India because it was not a colony, but a dependency, and we could arrange the tariff as we liked. He agreed with the necessity of reducing the cost of the armaments as much as possible, though he did not see how it was to be done. The railway mania ended in a collapse, because speculation became much too rampant; the policy he advocated was the opposite of that, to encourage enterprise at times when speculation ran low, and materials and labour were cheap. He thought Mr. Bourne used the words "good trade" in a different sense to himself; he simply meant trade which was active at good profits. He did not think the wants of the country had much to do with the increased activity of trade; and if depression and bad times simply meant that production was ahead of consumption, how was it that at such times our exports fell off? An undue production would rather tend to increase exports. He would not touch on the question of the balance of exports and imports, but as a plain man, he could not understand the statements which were sometimes put forth on this point. By the remark about the Legislature forbidding the erection of new manufactories, he did not mean that no new industries should be developed, but that no one should be encouraged to put up new mills, when there were so many standing idle in which the work could be done. With regard to our relations with the colonies, he never dreamed of employing force; but so long as there was no portion of the colonies represented in the House of Lords, he did not see how they could be said to be treated as really an integral part of the Empire. The tone in which they were often spoken of was very invidious, as if they gave us a great deal of trouble and no return. Large amounts of money were spent on Scotland and Ireland, and he did not see why we should not sometimes spend Imperial money on the colonies. We could then appeal to them with more force on a question of tariff.

The CHAIRMAN in proposing a vote of thanks to Mr. Browne, said he did not agree with all the propositions contained in the paper, and should be inclined to amend the statement at the outset in the following manner:—"Trade is good when the necessary amount of capital is being skilfully and thriftily spent on sound commercial and industrial enterprises." One remark about agricultural depression, he could not pass unnoticed. One gentleman said he deplored that his own trade was so brisk in importation of grain, because it showed that the agricultural interest was suffering. Now to his mind, the agricultural interest was not suffering from low prices, but from the absence of quantity; it was held by the best farmers, that if we were blessed with good seasons, we should be capable of holding our own against the competition of America, and he only hoped that in those circumstances Mr. Harris would not be too great a sufferer from the renewed prosperity of that industry in which he (the Chairman) naturally took a deep interest. It seemed, to him, impossible to impose a protective duty on the importation of grain from America, and he would ask whether that free importation did not give our manufacturers the very best of all protection? It was owing to that, that in the manufacturing districts the rate of wages had been maintained at its present level. He agreed with Mr. Manuel as to the mischief done by enterprises not on a sound basis, or which did not answer any want. As far as he was able to go into the subject, and after consulting practical men, he had come to the conclusion that a deal of harm had been done by getting up companies to work cotton and other mills at periods of inflation. If the Legislature could do anything to prevent the starting of such enterprises, he did not think it would be overstepping its functions. At any rate, he had seen a statement that the French Government was considering what could be done to limit the speculation which had been so ruinous to the country. The tone of the discussion had been rather depressing, and if matters were as bad as had been represented, the prosperity of the country was somewhat remarkable. A great deal had been said about the Bank of England, but was it not the fact, that the rate of discount was really the thermometer, not only for business transacted in England, but abroad also? and as long as that was the case, he did not think the condition of the country was such as need inspire one with the amount of commiseration which had been expressed in such eloquent terms that evening. In 1870, the Savings Banks had 53 millions on deposits, in 1880, 78 millions. The incomes in 1870 were 445 millions, and in 1880, 578 millions, and these figures being taken from the returns of the Income Tax Commissioners, were certainly understated. At the same time, he admitted it was necessary for farmers, manufacturers, and traders to increase the skill with which they conducted their business; and he agreed with Mr. Pfoundes, that it was most important that young traders should study on the spot the wants of the foreign as well as English consumers. If he disagreed with a great deal of what had been said, it was, perhaps, because he was a regular reader of the *Economist*, and considered the doctrines therein expounded were, as a rule, admirable.

The vote of thanks was carried unanimously, and the proceedings terminated.

MAGNESIA.—A process for obtaining magnesia from sea water has been discovered by Professor Schloesing. A cubic metre of sea water, treated by lime, yields a precipitate of magnesia, in a gelatinous state, about 80 litres in volume.

Miscellaneous.

INDUSTRIAL & COMMERCIAL CONGRESS, LIEGE.

In connection with the Liége *fêtes* of this year, an Industrial and Commercial Congress was held in the University, under the presidence of M. Julien d'Andrimont, senator, and in the presence of the King of the Belgians. This Congress was due to the initiative of the municipal authorities of Liége, and was limited to the consideration of suitable means for extending direct and regular relations between Belgian ports and transoceanic markets, and of determining the organisation to be given to the export trade.

The PRESIDENT, in opening the deliberations, remarked that the Brussels Exhibition of 1880 had proved that Belgium yielded to no other country in the variety, the cheapness, and the excellence of her products; but the sudden reimposition, by neighbouring nations, of customs' duties, which had appeared for ever condemned by economical science, threatened to shut out markets that had been open for so many years. The productive power of the nation was rapidly increasing, while the outlets for its manufactures were being restricted.

Mr CHARLES PECHER, vice-president, called to mind that England upheld the principles of free trade in her immense Indian possessions, and Australia welcomed the commerce, the intelligence and the activity of all European countries, without distinction of race or nationality. Japan, hitherto closed to foreign nations, had now adopted a different policy; and even China was about to open its vast internal provinces to the commerce of the world. While, however, so many outlets were afforded for surplus production, Belgium suffered through her products being introduced by intermediaries, whereby she lost the honour and a large portion of the profit. Three large regions were open to Belgian commerce: (1) Australia, the Indian Archipelago, Siam, Persia, Manilla, and China; (2) British India, Ceylon, the Cape of Good Hope; and (3) the West Coast of Africa. It was, however, necessary, before all things, to found a society of commerce adapted to the wants, resources, and temperament of Belgium.

It was decided to restrict the deliberations to the five following questions:—

1. Examination of the improvements of which the means of transport between the ports and manufacturing districts are susceptible (export and navigation dues; and navigation by night on canals).

2. Discussion of suitable means for multiplying direct and regular relations between Belgium and transatlantic ports; the creation of new maritime services with regular sailings; bases and conditions of their working.

3. The organisation to be given to the export trade; institutions to be founded in Belgium and in foreign countries, such as export companies, banks, museums, &c.

4. Increased efficiency of the Belgian consular service for ensuring the commercial representation of Belgium in foreign countries.

5. Discussion as to the advisability of creating a Ministry of Commerce and Industry.

The Congress held three meetings, besides that of inauguration; and resolutions to the following effect were adopted.

I. That navigation dues be abolished in Belgium.

II. That regulations as to the navigation of canals be revised; that navigation by night be permitted, or at least the passage of bridges and locks one hour before dawn, and an hour after sunset.

III. The Congress, while opposing permanent subventions in principle, expresses the hope that the Government will facilitate, by temporary subsidies, the creation of regular lines of navigation, destined to bring about the establishment of new relations with transoceanic ports.

IV. The Congress expresses the hope that the project for a deep-sea harbour on the Belgian coast may be settled without delay.

V. The Congress expresses the hope that lighthouse dues be abolished;

VI. Also that pilot dues be suppressed, or at least materially reduced.

VII. In the interest of commerce and industry, permanent museums or exhibitions of raw or manufactured products, where all goods of Belgian origin might find a place, should be created by the Government.

VII. The Congress urges on Government the reorganisation of the consular service, and hopes that the number of consuls may be commensurate with the importance of Belgian relations with foreign countries; candidates should have experience in trade and industry, and obtain a certificate from the examining jury; and a consular school should be created.

IX. The Congress expresses the hope that a special ministry of commerce, industry, and agriculture be instituted, its utility having long been recognised by several interests.

The Congress came to no definite decision as to the third question; but, recognising the utility of forming an export company, or similar commercial institution for favouring the introduction of Belgian products into foreign countries, it appointed a Commission under the presidence of M. Julien d'Andrimont, to examine the remarks made during the deliberations, to draw up a report, and eventually to form a project of organisation as speedily as possible.

SYDNEY TECHNICAL COLLEGE.

A report from the committee of the Technical College, at the Sydney Mechanics' School of Arts, to the Minister of Public Instruction of New South Wales, has lately been published, from which it appears that the School of Arts was founded nearly fifty years ago, and that the first industrial exhibition held in New South Wales, in 1861, was conducted by a committee of the school. In 1873, the proposal of a Technical and Working Men's College, in connection with the School of Arts, was first discussed, and in 1878, the Colonial Parliament granted £2,000 towards the foundation of such a college. Steps had previously been taken to obtain information on various points of industrial education from similar institutions in England and elsewhere. In October, 1880, a Technological Conference was held at Sydney, under the presidency of Sir Harry Parkes, when certain resolutions were passed by the delegates from the County Schools of Art and Trade Societies; the first two being—(1.) That in order to properly develop the resources of New South Wales, it is considered desirable that technical education should receive greater support in the colony, and that the instruction imparted in the Technical or Working Men's College, at the Sydney Mechanics' School of Arts, be extended to the suburbs of the city, and to the principal county towns, as far as their requirements may demand. (2.) That it is, therefore, respectfully suggested that the Government should institute a proper system of technical education in science and art throughout the colony, under the direction of competent lecturers and teachers, and that the instruction afforded be principally of a practical character.

A return of the number of students who entered courses of study at the Technical College, from 1st January, 1878, to 30th June, 1881, show the following results:—1878, 595; 1879, 703; 1880, 1,047; 1881, 767.

Correspondence.

BOTANY IN RELATION TO ORNAMENTAL ART.

I much regret I had not the pleasure of hearing Mr. Hulme's most valuable and interesting paper on "Botanical Science in Relation to Ornamental Art," and joining in the vote of thanks it so justly merited. The subject being one especially interesting to me, I trust you will permit me to offer a few words in support of the very valuable teaching of the paper. The old and trite saying, "where there's a will there's a way," is applicable to the question; once convince artists of the value and importance of correct delineation of natural subjects, especially those of the vegetable kingdom, and the battle is won—for the means or way is all around and open to us. Of course the best way is to teach all young artists botany, and insist that they visit country scenes, fields, lanes, moors, and forests, and study nature in her own homes, and copy correctly what they see. It is not, I fear, the difficulty of the way, but the inclination to follow it which proves the stumbling block; for example, we offer to all students free daily admissions to these gardens under certain regulations, and here, within the sound of Bow bells, examples of all forms of our native flowers, so far as they can be grown in the smoke of London, can be studied at ease; and not only our English plants, but those common to all climes and quarters of the globe. But what are the facts? During last year we issued free admission orders for terms varying from one to six months to 710 students, of whom only 41 were art students, the remaining 669 being all students of medicine: in one case botanical study is insisted upon, in the other it is optional.

Thanks to the exertions of Mr. Hulme and other lovers of truth in the study of nature, the present artistic treatment of natural subjects is much in advance of that of a few years back, and more attention is given to correct drawing. During my forty years' residence in this garden, the battles I have had with artists in the hope of impressing them with the fact, as it appears to me, that the incorrect drawing of a flower is as monstrous as of that of the human figure, have been highly amusing, if not sad. I fear in no single instance have I persuaded one who thought it quite a matter of indifference, and of no moment, to paint six petals to a flower, where nature had given but five, to compose a human figure with six fingers; but why should nature be trusted as the best judge of beauty in the one case, and not in the other?

As Mr. Hulme so justly remarks, more attention as to form, time, and locality ought to be insisted upon, and as much in the vegetable as in the animal kingdom. Just one or two examples of disregard of these:—the lovely water plant, the well-known *Nelumbium*, so correctly drawn by the Egyptians on their monuments several thousand of years ago, has lately been tortured into a design, and treated as a climbing plant, twisting and twirling in sharp curls and screws over a trellis like a "bind-weed;" a group of Bengal tigers in their native lair, crouching at the foot of an Australian gum tree. I suppose, in this case the excuse might be, "the fact is, the tigers were copied from living models in the Zoological, and the trees from the same in the Botanic gardens." In many pictures treating that oft-repeated subject, "The infant Moses in the Bulrushes," the common English *Typha*, sometimes called by country boys "Bullrush" or "Catstail" is drawn, a plant, I believe, that never has grown, or indeed, could live in any part of Egypt. The grouping of flowers blooming at different times of the year in one composition, "all a blowing and a growing," or the tender beauties of the tropics braving the cold breeze on the outer walls of a northern castle; a water-plant basking on a warm, dry, wall—smiling at the wall-rue floating in the ditch at its foot—are facts in art, although not in nature, of such everyday occurrence as scarcely to be noticed.

As to "conventionalism," I confess the science is far beyond me, and not having studied it, of course, do not pretend to say a word, only that I trust no votary of "High Art" will be tempted to take any one of my loved treasures from Flora's basket, and torture its beauty into a companion of the far-famed "Griffin."

William Sowerby.

Botanic Gardens, Regent's-park.

General Notes.

Tunnel between Italy and Sicily.—The *Bollettino della Finanza, Ferrovie e Industrie* states that the Venetian Society of Public Works has asked the Government for authorisation to make surveys for a project of railway communication between Sicily and the main land, by means of a submarine tunnel under the Straits of Messina.

Australian Railways and Telegraphs.—The following statistics for the 31st December, 1880, will show the number of miles of railways and electric telegraphs in the various Australian Colonies :—

	Miles of Railways open and in course of construction.	Miles of Telegraph wires.
Victoria	1,213½	6,019¼
New South Wales	1,305½	13,188
Queensland	805	8,150
South Australia	986	6,904
Western Australia	92	1,592¾
Tasmania	172½	1,096
New Zealand	1,466	9,401
Total	6,040½	46,351

Society of Telegraph Engineers and of Electricians. — Lieut.-Colonel Webber, R.E., President, delivered his inaugural address on Thursday evening, 19th inst. He congratulated the Society on having entered into the second decade of its existence, and pointed out the various ways in which the Society had been useful to the scientific world at large, as well as to the State, in its use of electricity for the service of telegraphs in the Navy and the Army. After alluding to the International Congress of Electricians, and the late Paris, and the coming Crystal Palace, Exhibitions, he referred to the labours in electricity and magnetism of Dr. Gloesner, once Professor at the University of Liege. His works were comparatively unknown in this country, and this opportunity was taken of rendering tribute to his memory, by mentioning some of his early researches since 1822, described in his manuscripts exhibited at the Paris Exhibition. Colonel Webber concluded by pressing on the Society that the time had arrived when a clear demand was evident for an Electrical Education Institution, where a thorough practical and theoretical training could be given to the numbers who are now crowding into the various new employments requiring a knowledge of the applications and laws of electricity.

Education Department.—It has been announced in the *Times*, that Colonel Donnelly, R.E., member of the Council of the Society, has been appointed to succeed Mr. MacLeod (who has resigned) as Assistant Secretary of the Education Department, and that he will also retain his present post as Director of the Science Division.

Railway Signals.—The railway alarm signal for passengers on the Emperor Francis Joseph Railway, Austria, consists of rods under every carriage, coupled together and communicating by a system of cords and pulleys, with the steam whistle. Other cords, passing round pulleys are attached to the rods, and are led to each compartment, the ends being protected by a frame closed by a sheet of paper. This paper must be burst open before the signal can be given by the passengers.

Conservatoire des Arts et Metiers, Paris.—The following is the programme of the free and public lectures on applied science for the winter of 1881-2 Col. Laussedat, the new director, lectures on applied geometry; and M. de la Gournerie on descriptive geometry. M. Tresca, the sub-director and well-known savan, gives a course of mechanics applied to the arts; M. E. Becquerel, on applied physics; and M. E. Trelat, on civil construction. General chemistry in its relation to industry is dealt with by Professor Péligot; industrial chemistry, by Professor Aimé Girard; chemistry applied to dyeing, pottery, and glass, Professor de Lugnes; and agricultural chemistry and chemical analysis by Professor Boussingault. Agricultural works and rural engineering, with spinning and weaving, complete the programme of this perfectly free and open course of technical education under the auspices of the French Government.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

February 1.—"Stained Glass Windows." By Lewis Foreman Day. George Godwin, Esq., F.R.S., will preside.

February 8.—"The Manufacture of Ordnance." By Colonel Maitland. Sir Frederick Bramwell, F.R.S., Chairman of Council, will preside.

February 15.—"The Art of Turning." By P. W. Hasluck.

February 22.—"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. Emerson Dowson.

Foreign and Colonial Section.

Tuesday Evenings, at Eight o'clock :—

January 31.—"The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation." By William Cochran.

FEBRUARY 7.—"Notes on the Trade Capacities of Newfoundland." By E. HEPPLE HALL.

FEBRUARY 28.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Moscow.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

FEBRUARY 23.—"Photometric Standards." By HAROLD DIXON. Dr. A. W. WILLIAMSON, F.R.S., will preside.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

FEBRUARY 17.—"The Depreciation of Silver as it affects India." By J. M. MACLEAN.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Second Course will be on "Recent Advances in Photography." By Captain ABNEY, R.E., F.R.S.

LECTURE 1, JANUARY 30.—Introduction. Direct action of light. Action of light and development. Daguerrotype. Phenomena met with in photographic experiments.

LECTURE 2, FEBRUARY 6.—The effect of the spectrum on the different molecular forms of the silver haloids. Practical applications. Sensitisers considered. Sensitiveness of the different salts of silver. Sensitometers considered.

LECTURE 3, FEBRUARY 13.—Dry plate processes. Instantaneous pictures. Instantaneous shutters. Enlargements, direct and otherwise produced. Colour of developed prints. Applications of photography to science.

LECTURE 4, FEBRUARY 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Capt. W. de W. Abney, "Recent Advances in Photography." (Lecture I.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Cuthbert E. Peek, "Across Iceland by the Springisandr Route."

Institute of Actuaries, The Quadrangle, King's College, 7 p.m. Mr. H. W. Manley, "On a certain Method of Distributing the Surplus among the Assured, and the Construction of an Equitable Scale of Office Premiums with reference thereto."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. Harrison, "The Real Value of Mechanical Inventions to Civilisation."

TUESDAY, JAN. 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. William Cochran, "The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. G. McKendrick, "The Mechanism of the Senses." (Lecture III.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. Charles W. Folkard's paper, "The Analysis of Potable Water, with Special Reference to the Determination of Previous Sewage Contamination."

WEDNESDAY, FEB. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Lewis Foreman Day, "Stained Glass Windows."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. James Wheeler, "Iodine-yielding Algæ; a proposal for their more direct use in Pharmacy." 2. Mr. M. Mitchell Bird, "Does Cod Liver Oil contain ·05 per cent. of Iodine as stated in Garrod's 'Materia Medica.'" 3. A collection of Madagascar drugs will be exhibited by Dr. Parker, of Madagascar.

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. C. W. Dymond, "Stone Circle at Duloe, Cornwall. 2. Mr. W. Myers, The "Excavations of a Roman Villa at Benizza."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.

THURSDAY, FEB. 2...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Otto Tepper, "Note on the Medical use of *Medicago uncinata*." 2. Major-General Benson, "Remarks on Elephant Flukes." 3. Mr. Robert D. Fitzgerald, "Botanical Sketch in connection with the Geological Features of New South Wales." 4. Mr. Otto Tepper, "Observations on Animal Intelligence."

Chemical, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. James Sully, "The Causation and Phenomena of Dreams."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. N. Moseley, "Corals." (Lecture III.)

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. E. Middleton, "Practical Ironwork."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, FEB. 3....Royal United Service Inst., Whitehall-yard, 3 p.m. Lieut. C. Campbell, R.N., "Signalling and Conveying the Orders of a Naval Commander-in-Chief."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly meeting. 9 p.m., Professor Tyndall, "Action of Molecules, Free and Constrained, on Radiant Heat."

Geologists' Association, University College, W.C., 8 p.m. Annual Meeting and Conversazione.

Philological, University College, W.C., 8 p.m., Rev. H. Belcher, "The Middle Verb in Latin."

SATURDAY, FEB. 4...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Ernest Pauer, "Ludwig Van Beethoven." (Lecture III.)

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FRIDAY, FEBRUARY 3, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PHOTOGRAPHIC EXHIBITION.

The Exhibition of Photographic Appliances, in connexion with Captain Abney's Cantor Lectures on "Recent Advances in Photography," was opened on the evening of Captain Abney's first lecture, January 30th. The Exhibition will be kept open till February 25th, every day from ten to four, and on Wednesday evenings from six to ten. On Monday evenings the Exhibition will be open to those attending the Cantor Lectures.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

Persons not members of the Society, who are interested in Photography, may obtain tickets on application to the Secretary.

Arrangements have been made for showing the actual working of some of the more recent printing processes, and it is probable that illustrations may be given of photography by various artificial lights.

A catalogue of the exhibits is issued as a supplement to this week's *Journal*. Copies of the catalogue will also be printed separately, for the use of visitors, and an account of the Exhibition will be given in a subsequent number.

CANTOR LECTURES.

The first lecture of the course on "Recent Advances in Photography," was delivered by Captain Abney, R.E., F.R.S., on Monday, the 30th ult. The principle of direct action of light, and the process of development, were explained, and the Daguerreotype process was demonstrated by Mr. England. The Fox-Talbot process was also shown. Photographs were taken by means of the electric light, and illustrations of the processes were also thrown on the screen.

PARCELS POST.

The Council have under consideration the advisability of arranging for a deputation to wait upon the Government, for the purpose of urging the adoption of a Parcels Post. Any members of the Society who may be in possession of information respecting the working of the system as in use on the Continent, will oblige by communicating particulars to the Secretary.

INSTITUTIONS IN UNION.

The following Institution has been received into Union since the last announcement:—

The Eurasian and Anglo-Indian Association, Mysore Branch, Bangalore, India.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, January 26th, 1882; Edward Frankland, D.C.L., F.R.S., Member of Council, in the chair.

The paper read was—

RECENT RESEARCHES INTO THE THEORY OF THE LIVING CONTAGIUM, AND THEIR APPLICATION TO THE PREVENTION OF CERTAIN DISEASES IN ANIMALS.

By J. L. W. Thudichum, M.D., F.R.C.P. London, &c.

The consideration of virulent diseases to which man and animals are liable, constantly engages the attention not only of the medical profession, but of all thinking members of the community. The prevention of these diseases is of course desired by everybody, but it cannot be effected by the medical profession alone, or by the public alone, or by either of them with the aid of the Legislature alone, but requires the cordial, constant, and energetic corporation of public, Government, and doctors. The public have to co-operate in the prevention of these diseases, not only individually, each by the proper hygienic conduct of his person, family, home, cattle and land, but also in corporate capacities, as communal representatives, and in the latter case with responsibilities growing with the power which may be attached to the capacity. Such being the case, it is desirable that the co-operation should consist not merely in obedience to skilled prescriptions or man-made statutes, but in that intelligent obedience, which is the result of a more or less perfect knowledge of natural things and causes. From this point of view the consideration of virulent diseases becomes a part of natural history, which it behoves every cultured person to know just as he knows astronomy, botany, or physics, or history. And this being granted, it will, I hope, require no apology on my part, that the Council of this Society thought it useful, on public grounds, that the subject indicated by the title of this paper should be discoursed on and discussed in this hall.

Although by the title of the paper I am, happily for myself, confined to *recent* researches, it will be necessary for me to show you that, and how, they are based upon and cohere with knowledge which men of science of many nations have produced, and stored up during long periods of time. This knowledge has mainly been obtained by the study of some of the most virulent diseases of animals, with the aid of pathological experiments upon living animals, and could by no means have been obtained without them; and now the species which furnished the hecatombs of victims of disease, and the insignificant number of subjects for experiments, are about to be benefited, or are already benefiting, by the practical results of these studies, to the extent of their being practically free from the liability to at least the most pernicious of contagions and almost certain death, which formerly troubled their prospects.

Some may perhaps think that there was some inconsistency in my discoursing of the theory of contagion, and yet claiming practical results for its application. To be better understood by these persons who merely follow a common habit of confounding theory with hypothesis, I expressly say that I use the term theory in the genuine Greek sense, as expressing a scientific view which can be made the basis for action. And I further include, for my present purpose at least, in the term theory in general, all theoremata, or theoremes, as special cases, and demand for them, as diagnostic conditions, the properties postulated by Galen, namely, that they must be, before all else, true; further, that they must have a fructiferous influence upon our subject; and lastly, that they must be derived as necessary consequences from the antecedents.

A contagium is a cause of disease which can be communicated from one individual to another, by some material contact or other only; the term contact here includes not only that immediate contact, in which, *e.g.*, a person nursing a patient comes within the object of his attention, but also in direct contact, such as that to which a washerwoman is liable when she handles the clothes of a sick person. In all cases a contagium is a material particle, or number of particles, which is transferred from a specifically sick person or animal to a healthy person or animal, and produces in the healthy person the same disease as that which affected the person or animal from which it proceeded.

In order to understand how such a contagium can be living, it is necessary to be acquainted with the nature and properties of the smallest organisms occurring in nature! From the consideration of all that is known on this subject, it follows that contagia, which can be distinctly recognised as consisting of a number of similar individuals, belong not to the animal, but to the vegetable kingdom, and therefore the term living contagium would require to be supplemented by the adjective vegetable, if it were not probable that all contagia whatever belong to the world's flora, and not to its fauna. In any case there are no grounds for terming contagia animate, if the condition of animation is allowed to characterise organisms which, in science, are termed animals. In short, contagia, such as we know then, have the characters of the lowest plants.

The term "contagious disease," is, therefore, equivalent to that of "vegetable parasitism." But the equivalence is not absolute.

Itch is contagious. The spider-like *(arachnid)* mite, which is the sole cause of itch *(scabies)*, is an animate contagium. It can be transferred from one individual, on which it lives, and propagates, and causes eruption, to another healthy one, and cause the same disease of the skin as that found on the body from which it came. It can be killed by chemical agents, and, with its death, all manifestations of disease cease, and all effects heal.

Trichiniasis is contagious. The minute worms can be transferred, in a particular manner, from one individual (human or animal) to another, and, by its multiplication, cause a disease which is very similar to an ordinary contagious disease. But there is a great difference in the manner in which the organism of the animal invaded by any of these animal parasitisms reacts against the invading force. And it is by this reaction mainly, which has a remarkable intensity and effect in the case of contagious diseases, that animal parasitisms are distinguished from vegetable.

The reaction of the organism invaded by a vegetable contagium consists in this, that whenever the organism does not actually succumb, it acquires a new property, namely, that of being thereafter, either for the length of its entire life, or for longer or shorter periods, so to say, inaccessible to the same, or a very similar, contagium. Thus, a person is not very liable to contract yellow fever twice; and small-pox, typhoid fever, or cattle-plague so rarely befall the same individual twice, that one attack is generally considered to protect the survivor from a second one. The condition of body thus acquired is generally described as immunity. This immunity is never produced as a result of animate contagium. A man who has recovered from an attack of itch or trichiniasis, is just as liable to a second infection, or any number of infections, by the acarus of scabies or the trichina, as he was before the first attack. But a man who has recovered from the small-pox is not liable at all to contract small.pox again, for a considerable time at least, and even when the contagium, which would give the small-pox to a healthy person with certainty, is incorporated with his body, it fails to thrive, perishes, and becomes abortive. This undoubted state of immunity from the disease, produced by the disease itself, is one of the most difficult problems of medical science. There is at present no explanation of it for which there could be quoted even the outline of plausibility. It is, however, undoubtedly the result of the reaction of the organism against the contagium and its products. It is a function not of the contagium, but of the organism invaded.

This immunity exists in a proportion of healthy individuals without their having undergone the effects of the contagion in their proper persons. In such cases the immunity may be inherited, or have been acquired by means which do not present themselves as actual contagion. Or it may have been acquired by a vicarious contagion, which, like cow-pox, exhausts the receptivity of the individual for cow-pox as well as small-pox, or confers the mmunity from cow-pox as well as small-pox. For immunity may be the result of an active power acquired, or of the loss of a passive faculty, such as impregnability.

We will now first consider some of the best known vegetable parasitisms or contagia, and their action upon the beings upon which they thrive best, and develop their highest power of destructiveness.

In New Zealand there lives a common caterpillar, which, when it is nearly full-grown, frequently begins to sicken; a bump appears at its head or neck, and then a fungus sprouts out an inch or two in length. When the fungus has ripe spores, the caterpillar dies. You can see caterpillars of this kind, with fungi attached, exhibited in the Natural History Museum in South Kensington. This is the most grotesque vegetable parasitism of which I know. A single spore introduced into the body of the healthy caterpillar will produce the disease; a mycelium forms in the cavity of the body, and the external growth is only the rapid infloration of the hidden growth. In Europe we have a disease of a similar kind, but without the grotesque mushroom sprouting from the surface of the animals, namely, the disease of silkworms, termed muscardine. In this disease the animals die as from an unseen poison, and only by close observation after death is a film of fungoid infloration, carrying spores, seen upon their surface. It was the Italian Bassi, who, in 1837, discovered this remarkable fact, upon which all our present knowledge of this subject is based. He cultivated the spores taken from the skins of silkworms which had died from the muscardine or moist moss, and was able to reproduce both mycelia and spores, and with the new generation of spores produced out of the body of the silkworms, he was able to reproduce the muscardine in silkworms, either by inoculation under the skin of the worms, or by infecting with the spores, as dust, the air which the worms had to breathe, or by casting the spores on the leaves which the worms had to eat. He thus handled his disease cause so as to show that it was not only a true contagium, but at the same time, a good imitation of a miasm.

These discoveries of Bassi, which at the time when they were made appeared to interest only silk growers, became the starting point for one of the most perfect deductions ever made in science, but doomed to be ignored and to be forgotten; I allude to the pathological researches of Henle, now professor of anatomy at Göttingen, published in 1840. In one article of these researches the theory of living contagium is developed as an hypothesis in all its details, and it is shown that the features of contagious diseases harmonise with the hypothesis in a very remarkable manner.

But the hypothesis lacked the basis of direct experimental evidence. This evidence could not be got out of the consideration of human contagia (it cannot be obtained so now); these had been investigated with rare patience and skill by thousands of physicians, and yet the essence of the nature of virulent disease was as hidden as ever. The method of experiment had to be discovered by the cultivators of another science, that of botany. It was mainly Schwann, the author of the cell theory, who opened new ground, by showing that the phenomena of alcoholic fermentation are connected with the presence and life of elementary minute plants, particularly the yeast-plant.

This development was contested by chemists, who in view of the magnitude of the chemical changes induced during fermentation, endeavoured to explain it by analogy more than direct study. And thus it came that what was in itself unexplained, namely fermentation, was made a type to which diseases were compared, and henceforth contagious fevers were termed zymotic diseases, or *zymoses*. This was no doubt partly caused by the observation that "the true or metabolic contagia—the contagia which in their respective and specific ways, operate transformingly on the live bodily material which they affect," as Mr. Simon has tersely defined them, produce a great chemical motion in the body, which results in the rapid production of highly oxidisable compounds, and their oxidisation being effected *pari passu*, the temperature of the body is raised more or less above the normal point, and the state called fever, or *pyrexia*, is produced. Hence, fermentation and fever become comparable, not only by their chemical course, but also by their potential effect. The purely chemical view of fermentation was mainly elaborated and defended by Liebig, and he made it so probable, that it may be said to have reigned supreme almost to the end of his life. It is only during the last ten years that his opponents have made their views generally prevail, and with results of which we must admire, not only the scientific brilliancy, but also the practical utility. Amongst these, none has worked more arduously and more successfully than Pasteur. During 24 years he communicated numerous researches bearing upon alcoholic fermentation. Of these a cardinal one concerned the production by growth, by multiplication, of the yeast cell in artificial nutritive solutions, free from all albuminous substances. From this moment the theory of Liebig had no longer any foundation, and, says Pasteur, the phenomena of fermentation presented themselves as simple phenomena of nutrition, which take place under exceptional circumstances, of which the strongest and most significant one is this, that air may be excluded from the process. This gave a new impulse and direction to the study of animal contagia. They reverted to the method of Bassi, and his follower Audouin, and to the line of thought so well worked out by Henle. In 1863, Davaine resumed his studies of the bacterium of splenic fever of cattle, which Rayer had first shown to be the essential contagium of that disease, by experiments upon living animals, but without any new results. Chauveau, however, by experiments upon contagious matters, such as those of small-pox or cow-pox, endeavoured to uphold the proposition that all contagia are particulate, that all contagiosity in a mixture (such as animal contagia are) resides in its solid particles, and not in its liquid part. After the experiences of the German-French war of 1870, we find the wound-poison ascribed to microscopic organisms by Klebs, and we find the same conviction in this country raised to a general theory, and applied with apparently excellent results to the treatment of all wounds by Lister.

In 1876, an important progress in the direct appreciation of contagia was made by Koch, then working in the botanical laboratory at Breslau. He sowed the bacteria of splenic fever in inorganic solutions similar to those in which Pasteur had reared yeast-plants, and found them grow, develop their germs or spores, and then again grow into bacteria. The new generation of bacteria proved as disastrous to animals as those taken from animals directly. Here, then, was a true or metabolic contagium found out to be an alga-like low plant, to grow in proper media like Bassi's muscardine spores, and to kill as certainly after as before the digression into and propagation in cultivation media.

There is a disease of fowls, called in France "cholera of chickens," from which many die, when once it has got access to a fowl-yard. The animals affected become torpid, are entranced with somnolence, and die without moving from the spot, the head, as in sleep, under the wing. This disease, too, is caused by a microscopic organism, first suspected by Moritz, a veterinarian of Upper Alsatia, figured by Peroncito, a veterinarian of Turin, and cultivated by

Toussaint, a veterinarian of Toulouse, in the manner in which Koch had cultivated the bacterium of splenic fever and with the same success. This organism was now studied by Pasteur, and he found that, while it throve well in chicken broth neutralised by soda, it refused to live in decoctions of yeast, such as would support the splenic fever bacteria, and enable them to multiply. The chicken cholera microbion killed chickens rapidly after inoculation; it did not kill guinea-pigs, but merely made them ill for a time, by producing a small abscess. The contents of the abscess always contained the microbion, which when re-inoculated to chickens, killed them rapidly. Chickens which merely ate some of the pus from the abscess of the guinea-pig, died rapidly, and the fæces which they voided during the short sickness swarmed with the microbia. The microbia were easily destroyed by a little diluted sulphuric acid, but they retained all their virulence after cultivation in neutralised chicken broth; and this virulence was so great, that if the point of a needle was dipped into a cultivation solution in which the microbion was growing, and was then plunged into the tissue of a fowl, the latter died—mostly in twenty-four hours. Of twenty fowls thus treated, all twenty died in two or three days—most commonly in fifty-four hours. Pasteur now found that by certain changes in the mode of cultivation of these microbia (changes which will be alluded to lower down), the infecting energy, or as we perhaps better express it, the metabolic virulence could be greatly diminished. The modified microbion would make twenty chickens specifically ill, but kill only few or none. And these twenty or eighteen chickens, after recovery from the modified disease, would be protected from the influence of a renewed introduction of the same contagium, as well as of the first always fatal form of the disease. Pasteur had therefore repeated upon fowls the old experience of protection by inoculation with a modified specific contagium. Inoculation with small-pox was based upon the recognition of the existence of such modified, or mild small-pox. Cow-pox, which was supposed to be a contagious disease peculiar to the cow, and to act vicariously, in protecting men from small-pox, were supposed by some to be modified small-pox only. And this view was sufficiently strong with some—as with Badcock of Brighton, Ceely of Aylesbury, and Green of Birmingham—to induce them to inoculate cows with small-pox, and to use the (modified) contagion thus produced for the protective inoculation of men, commonly termed vaccination. Much of the so-called "vaccine" lymph now used in England is actually small-pox lymph modified by one passage through the heifer, and many passages through human beings. But in the case of small-pox and vaccine, it has not yet been shown that the virus is a living being, whereas in the case of the virus of the fowl-cholera, the "mitification," if I may be allowed the term, was effected after the living nature of the contagium had been ascertained.

When the microbion in its virulent state is inoculated in the great pectoral muscle (the breast of the fowl), it multiplies there, and destroys much muscular tissue. But at last it becomes confined in a cavity with pus, and with the piece of muscle destroyed, continues in it as a sequestrum. Here the general disease ends; but the microbion remains living and capable of propagation in new individuals. The abscess may be emptied out and will heal with the necessary contraction by loss of substance. Now the pectoral muscle is protected from the effects of any similar inoculation; it has acquired a special immunity, in which, if I understand M. Pasteur right, the rest of the body of the fowl does not share. The immunity of the entire fowl is only obtained by protective inoculation with the modified, not with the original, so to say, wild poison. Pasteur supposes that this immunity of the muscle was, in fact, an incapacity to nourish the microbion, caused by the suppression (or removal in the shape of pabulum) of some principle or matter which life does not restore, and without which the microbion cannot be developed. This local immunity is part of the question of the immunity of entire organisms. From this immunity, says Mr. Simon, the inference seems unavoidable, that each contagium operates with a chemical distinctiveness of elective affinity on some special ingredient or ingredients of the body; and that exhausting this particular material in febrile process, which necessarily ends when the exhaustion is complete, is the bodily change which the contagium specifically performs.

However that may be, it is certain that, at this point, the investigation of the effects of living contagia must be taken up by the pathological chemist. For the phenomena indicate various chemical changes, not only of parts of the body, but also of matter emanating probably from the microbia themselves. For when, *e.g.*, the microbia of the fowl cholera are cultivated in a proper previously sterilised solution, and when this solution is now filtered so as not to contain any microbia; and when this solution, free from microbia, and which cannot therefore produce any disease like fowl cholera by inoculation, is injected into the subcutaneous tissue of a fowl, the animal shows some nervous disorder, and some yawning-like motion of the beak; it then becomes somnolent as in the fowl cholera itself, but after about four hours recovers as from a dose of a narcotic poison. The microbion, therefore, produces a narcotic poison during its life, which acts upon the nervous centres. The disease, as a whole, consists therefore of lesions of different orders; one caused by the microbion, its obstruction of lymph—and blood-vessels, its abstraction of oxygen from the blood-corpuscles and other effects; the other order being chemical effects of a truly poisonous kind, caused by substances new to the economy, and excreted by the microbion, or left as residues of decomposition which it engenders.

But I must not discuss at too great length a disease which has probably little practical importance in this country. The fowl-yard has its diseases, and diphtheria is one of them. Young pigeons die frequently of the same disease. It would be well if all could be protected or cured. We, for our part, must pass to perhaps the greatest result of Pasteur's studies, namely, the protection of cattle—oxen, cows, and sheep—by protective inoculation, with a modified bacterium of splenic fever or anthrax, against the true and hitherto frequently fatal disease, splenic fever. Chauveau, of Lyons, while experimenting with splenic fever contagium on sheep, which he had bought in the open market at Lyons, had found that nine sheep in succession were proof against it. On inquiry, he learned that these sheep had been imported from Algiers. He then imported seven sheep from Algiers directly (Constantine), and inoculated them with splenic fever contagium of a virulent kind. A test-sheep, from Dauphinée, was also inoculated. The latter died within three days, while the seven Africans showed no splenic fever symptom, except a slightly raised temperature. Five of the Algerian sheep were inoculated twice more, with test animals by the side of them; amongst the latter being Tuscan sheep and lambs, Piedmontese sheep, and a rabbit. All the latter died, while the Africans exhibited a perfect immunity. Chauveau now went to Algiers, and experimented further; out of 47 sheep inoculated, only 8 took the disease and died; 39 resisted to all repeated noculation. Thus it was proved, for the first time, that some sheep could resist the splenic fever poison, which, with European sheep, had been always fatal.

Pasteur now investigated, with the aid of the French Government, the manner in which animals might become infected with splenic fever. When sheep were made to eat clover (*lucerne*), on which bacteria, reared from splenic fever contagium, had been poured, several died, but after a period of incubation extending sometimes to eight and ten days, while the greater number escaped infection. It was, therefore, probable that many of the infections occurring in France, and which amount to three per cent. of all the flocks annually, were caused by bacteria, accidentally on the ground and on food, and swallowed by the animals with their food while pasturing. This surmise was proved, experimentally, to be probable. When animals, dead from splenic fever, were buried in arable or pasture-land, and healthy animals were allowed to pasture over the graves, the latter became infected with splenic fever It was now shown that, when the splenic fever contagium is in the filiform stage, it perishes with the putrifying body, as it cannot live without air; but when it is in the stage of spores, or germ-corpuscles, it is not affected by want of air, and survives. Such spores are found in and above the burying-places of animals dead from splenic fever ten and fourteen months after burial, and are capable of causing the disease in new animals. Even above animals buried two metres deep, these spores were present two years later. These germs are carried to the surface by earth worms, in whose interior they are also found. The little cylinders of earth, deposited by the worms as fæces, contain the germs of the splenic fever contagium; and the rain, when desintegrating these little heaps of cylinders, spreads the germs about, causes them to adhere to adjacent vegetables, and to be carried into watercourses or ditches.

Pasteur now proposed prophylactic burial of all animals which might die from splenic fever, and believes that with these measures alone the disease could be stamped out in a few years. (It had been stamped out on German farms in Saxony, an experience which is related in a letter from the Saxon Minister to the French Court in 1865.) Meanwhile, Toussaint made experiments concerning the inoculation of cattle with a mild splenic fever contagium, for the purpose of protecting them in the same manner as men are protected from virulent small-pox, by inoculation with a mild form. These experiments succeeded partially; some animals died, but the survivors, which were the great majority, were protected from the effects of renewed inoculation. Similar experiments were successfully made in this country by Greenfield, now of Edinburgh. On the whole, it was again found by test experiments that cows are much stronger in resisting splenic fever than sheep, Of 20 cows whieh were inoculated with splenic fever in 1850 to 1852, by the *Association Medicale de Chartres*, only one died, while of 47 sheep inoculated by the same association, 35 died and 12 survived. While, therefore, the cow does naturally frequently fall ill with splenic fever, it does not always die, or rather rarely dies, while sheep die in the great majority of instances in which they become infected, Barbary sheep always excepted.

Pasteur now studied further the mode of attenuating, as he termed it, the contagion of fowl cholera. He had observed the first attenuated virus when he took some from a fowl which had indeed died from the cholera, not, however, from the acute, but from the chronic form, and had cultivated it for weeks and months in successively renewed solution. At first it lost nothing of its virulence; but when the cultivation was renewed unintermittedly during from six to eight months, and at longer intervals between the sowings, the fatality of the disease, following inoculation with this cultivated contagium, diminished or disappeared. A contagium was produced, which caused a mild, non-fatal disease, and the animal which had undergone this process, was protected from the effect of the most virulent contagium, as has already been stated above. What is of importance now, is the cause of the attenuation. Pasteur surmised the oxygen of the air to be the principal cause of it. If the virus is cultivated in hermetically sealed tubes, with only a limited amount of air, no attenuation takes place, and a tube, thus charged, and kept for as many as ten months, retains the contagium in all its original virulence. This feature he believed to be a principle to which other contagia might show obedience. This was found to be the fact for the splenic fever contagion. Cultivated in the presence of air, and re-sown at long intervals (the intervals are not accurately stated, and differ for different cultivations, as some of the crops die after short cultivation, particularly when they are already somewhat attenuated, while others, of virulent strength, may have their sowing deferred much longer), the bacterium changed its character; it became incapable of causing death in the most susceptible animals, but retained the power of producing some slight febrile disorder, after the disappearance of which the animal was inaccessible to the most virulent form of the contagium. It was as proof against splenic fever as a vaccinated person is against small-pox. The experience was now raised to a method of protecting herds from splenic fever. Test experiments were made, at the public expense, and under responsible inspection and control. Pasteur having predicted the results to the Commission, which had made a record of the prediction, was fully borne out by the results which the Commissioners had to verify. All non-protected animals which had been inoculated with active virus, were dead; all animals previously protected by inoculation with modified virus, and now tested with active virus, were living and well. Since that time, many thousands of French animals have been inoculated with the modified virus, with the view of protecting them from spontaneous splenic fever, *i.e.*, splenic fever which they might accidentally contract where the germs of it occur.

Many are the diseases which are ascribed to, or are actually proved to be caused by, bacteria, similar to, though mostly much smaller, than those of splenic fever. One of the best known is pig-typhoid, so ably elucidated by Dr. Klein. Lately, a new one has been discovered by Dr. Ballard, probably also originating in the pig, and affecting men who consume the pork—even when cooked.

But I must hurry to conclude this very imperfect account of one of the most important subjects of modern science. There are not wanting objectors to the protective inoculation of animals, as there are those to vaccination. They will do good by opposition if it be founded upon truth and experiment, particularly on animals. Probably the stamping out of this and kindred diseases by isolation of cases and germs might be preferable to general inoculation. But antidotes—true medicines—are wanted for most of the virulent diseases, and it is in their discovery that the chemical method of investigating disease will, in the future, meet with its greatest successes.

DISCUSSION.

Mr. Clements said that, unfortunately, the public did not take sufficient interest in this subject. Because they could not see germs, they thought they did not exist, and were indifferent to sanitary matters until sickness occurred. The reader of the paper had not referred to pleuro-pneumonia. On that many experiments had been made by Professor Symonds and others; but he believed it was always found that in the case of this disease inoculation was powerless. He thought it was a pity the Government in this country did not support scientific men to a greater extent in such researches, in the same way as M. Pasteur was supported in France.

Mr. Kingzett expressed his pleasure at the extremely lucid exposition of the germ theory which had been given by Dr. Thudichum. Although a short time since there were many chemists and others who fought somewhat strongly against the teachings which at that time were beginning to take hold of scientific men, the more recent researches had been so conclusive, that but few had now any doubt of the truth of the germ theory, as put forward that evening. Still, while they clung to what had been absolutely approved, it was of the first importance that they should not be too hasty in generalising, or go beyond the limits of legitimate inference. No one would doubt that splenic fever, pig typhoid, and several other diseases, were actually caused directly by spores of certain fungi; but when one attempted to carry the analogy to the elucidation of small-pox, and similar diseases, enormous difficulties arose, and the arguments, in fact, served no useful purpose. Even if they ever arrived at such a stage in the history of the germ theory of disease, as to be able to say that small-pox was caused by the spore of a fungus, they must also draw another conclusion, which was to-day resisted by the medical faculty *en bloc*, viz., that small-pox could arise *de novo*. At present, the current feeling was, that one case of small-pox could only follow its producers—that it was always a case of direct transmission from one patient to another. This was a very important consideration, and one well worth bearing in mind, in face of the present search after a more perfect system of health. The reader of the paper had not mentioned the experiments of Dr. Burdon Sanderson, because, of course, it was impossible to go into so many subjects, but his experiments did lend very great weight to the others named in the paper. He might refer specially to Dr. Sanderson's experiments on putrefaction. In putrefaction, no doubt, the great process was the splitting up of the albuminous principles by these fungi, and one of the products which was formed—a truly chemical product he took it, because Dr. Burdon Sanderson failed to cultivate it—was sepsine, which was also particulate, and which would, no doubt, contribute largely to the total toxic effects of putrid matter.

The Chairman, in proposing a vote of thanks to Dr. Thudichum, said this was a subject which had grown so much of late years, and had exercised some of the best intellects in England and America, and it now really occupied a position which twenty years ago would never have been predicted for it. The author had been, perhaps, a little too hard on the chemists, on looking back on their views of this subject of some twenty years ago, and condemning, as he did now, their somewhat one-sided ideas regarding these phenomena. Chemists, as Dr. Thudichum rightly said, looked to the reactions which existed when these fermentations and other operations were going on, and refused to look at any other side of the question, but now it would be very difficult to find a chemist who was not almost, if not entirely, a convert to this germ theory of disease. The cases which had been brought before them, were in themselves equally convincing, and the immunity which had been produced in animals by these processes, the inoculation of the virus cultivated in certain liquids for a length of time, were valuable contributions to hygienic science, and had brought them into a condition for further progress, which was exceedingly encouraging. That progress, however, obviously, from the remarks which had fallen from Dr. Thudichum, and certainly from his own conviction on the subject, could not take place if an intelligent and rational method of experimenting on animals was to be forbidden. He was very glad to hear the reader of the paper speak in such a hopeful tone about the effect of medicine upon these zymotic germs. He confessed that his own belief about the possibility of destroying these organisms which had once got possession of our bodies was very strongly shaken by experiments which had been made in his own laboratory. A quantity of mutton broth was affected by bacteria, and when swarming with these organisms, it was introduced into a vessel filled with mercury, and standing over that liquid. Then various gases were put into these globes, and, of course, in contact with this liquid teeming with bacteria. Oxygen was tried, hydrogen, nitrogen, carbonic acid, and all the ordinary gases, some of which were respirative by animals, and some of which were believed to be beneficial to plants; but the bacteria seemed to delight equally in either of them. They got on quite as well in carbonic acid as they did in oxygen; they could live for weeks without the presence of a trace of oxygen in the liquid, with nothing but pure carbonic acid. If the experiments had gone no further, they would show that these organisms had an extraordinary tenacity of life. But cyanogen was now introduced into the flasks, and, although they certainly did sicken a little under it, they recovered in the course of a week or so, and went on living in that gas in a fairly healthy condition. Sulphurous acid—the mutton broth itself being, of course, saturated with this gas, and the atmosphere of the glass globe consisting of nothing else but sulphurous acid—seemed to have very little effect on them at all; their motions were not stopped, and they seemed to be as lively after the application of it as before, and the same was the case with several other re-agents which were tried. It seemed, therefore, he would not say a hopeless, but very difficult problem for the physician to find out a medicine which would destroy these organisms before they destroyed the patient, for such vitality as theirs was certainly not shared in by the higher animals. He trusted, therefore, that these researches into the habits and the method of destruction of these organisms would, before long, put mankind into the same position with regard to them that it now stood in with regard to beasts of prey, and that it would eventually become as great a disgrace to have these different contagia affecting human beings as it would be at the present day if wolves were prowling about in the neighbourhood of the metropolis.

The vote of thanks was carried unanimously.

FOREIGN AND COLONIAL SECTION.

TUESDAY, JANUARY 31st, 1882; B. FRANCIS COBB, Treasurer of the Society, in the chair.

The paper read was—

THE PHYSICAL AND SOCIAL CAPABILITIES OF NEW ZEALAND FOR TEA AND SILK CULTURE.

BY WILLIAM COCHRAN.

> "Wherever the mulberry grows luxuriantly,
> There Nature indicates a suitable spot for tea."—
> *Oriental Apothegm.*

In former years, papers of an interesting character on tea and silk production in India, and on sericiculture in Australia, have occupied the attention of this Society. The present essay proposes to lay before it some notion of the facilities offered in New Zealand, particularly in the province of Auckland, for both industries conducted together as a twin enterprise, and to indicate a few of the social and other advantages likely to accrue to the Government, to colonists, emigrants, and natives, which may reasonably be expected to attend the settlement of tea and silk culture there.

New Zealand consists of North, South, and Stewart's Islands, and some small dependencies lying between 34 and 48 deg. S. lat., and 166 deg. and 179 deg. E. long., measuring about 1,100 miles in total length, and having a varying breadth of from 46 miles to 250 miles, yet with no portion of its territory beyond 100 miles from the sea.* Somewhat smaller in area than Great Britain and Ireland, it covers about sixty-four million acres, and was discovered, in 1642, by the Dutch navigator, Tasman, who, however, merely sailed round the group and gave it a name, but took no steps to secure possession for his Government. Between that date and 1769 no reliable record is known to exist of any stranger having visited these shores; but on the 8th October of the latter year, the illustrious Captain Cook landed in Poverty Bay, and he and his crew were probably the first Europeans who made acquaintance with a land which has since become an estimable jewel in the British crown. It is unnecessary to allude further to the long and anxious years of turbulent disputes and sanguinary quarrels, varied by occasional glimpses of order and progress, which followed, than to say that the British Government was at length prompted to step between the natives and settlers with the hand of authority, by annexing the islands in 1840. For a few years thereafter, under the influence of a rapid tide of emigration, and some colonising efforts, decided progress was made; but again came disputes, lawlessness, and bloodshed, which unfortunate state of things continued for over thirty years.

Such were some of the impediments to the development of the natural resources of New Zealand at an earlier date. With a deteriorated and diminishing native population; an atmosphere of perpetual wrangling and reciprocal violence between the colonists and Maoris; the long-continued difficulty of obtaining labour; and the crushing incubus of more than sixty years of chronic war, it is scarcely surprising that, even among ambitious settlers, until within recent years, only the more ordinary agricultural and manufacturing industries were followed, and that the scientific vocations of tea production and sericiculture still await the vivifying finger of enterprise.

TEA AND SILK IN CHINA.

At this point the questions may legitimately be asked:—What are the reasons for believing that "chasericulture" is suited to the climate of New Zealand; and, what are the prospects of success? To answer such queries are among the objects of the following pages, and as a beginning it becomes desirable, for the sake of perspicuity, to define the exact sense in which the comparatively new word *chasericulture* will be used.

Although the Chinese, strictly speaking, understand by the word *cha* only the watery infusion made from tea leaves for use as a beverage, in the course of their commercial relations with Europeans, it has come to represent also the dry prepared leaves as made up for exportation. Hence the term *cha-sze*, applied during the East India Company's reign to their valuers and inspectors at Canton by the Chinese; and the word is probably a modification of another, but very different looking character, *cha-t-sze*, used to indicate the refuse left during tea manipulation; formerly employed by the Chinese workmen in their days of innocence, in place of soap, for cleansing their hands. The next two syllables of the word "chasericulture," *seri*, are derived from the Latin word for silk; and the remainder of the term needs no explanation. As space will be saved, and exactitude promoted by its use, whenever in this paper the combined industries of tea planting, cultivation, and manipulation, mulberry planting and cultivation, silkworm hatching, rearing, and silk production, as far as the cocoon, are alluded to, the term "chasericulture" will be employed.

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* *Vide* "New Zealand as it was in 1870: as it is in 1880." By F. Whitmore Isitt. London: Haughton and Co.

Probably the best method of finding replies to the questions propounded will be, in the first instance, to glance at the principal features of the countries in which tea and silk farming are at present conducted. Of such, China is evidently entitled to the earliest and closest examination. There, the districts specially devoted to tea farming lie between 23 deg. and 25 deg. N. lat., and 115 deg. and 122 deg. E. long., comprising portions of the provinces of Canton, Chekiang, Fokien, Hounan, Hupeh, Kiangsi, and Kiangsu; whilst those in which sericiculture has attained its greatest development are Chekiang, Howquang, Kiangsi, Szechuan, and, notably, the district of Kiangnan, all traversed or nearly approached by the 30th parallel of north latitude. Both tea and silk of the best quality are produced in other parts of China; but it is in the localities named that chasericulture has, in one or other of its departments, become most firmly rooted, and is believed to exhibit the most satisfactory commercial results. Unfortunately, Chinese statistics, when uninfluenced by foreigners, are scarcely reliable; but, even if they were, no official records of thermal variations are known to exist, so that it is extremely difficult, if not impossible, to collect a series of averages available for comparison with those published annually in most other civilised countries. The student is therefore thrown upon the isolated, and often temporary, notes of the foreigners who, from time to time, have interested themselves in watching and recording climatic mutations in different parts of the Empire.

A series of thermometrical observations, extending over three years, made at Shanghai some time ago, resulted as follows:—

	Mean max.	Mean min.	Highest.	Lowest.
	Deg. Fah.	Deg. Fah.	Deg. Fah.	Deg. Fah.
January......	33	24	45	22
February......	33	26	46	24
March.........	43	31	65	30
April.........	54	42	63	41
May..........	70	58	88	50
June..........	80	69	97	65
July..........	92	74	113	60
August	91	75	99	66
September....	80	66	96	65
October......	75	54	89	31
November....	63	31	70	30
December....	38	30	47	24
Summation...	752	580	918	508
Averages.....	62·66	48·33	76·50	42·33

This port, however, being only twelve miles from the sea, greater variations of temperature than those recorded in the above diagram will, doubtless, occur in the more inland districts of the Upper Yangtsze, and on, or near the shores of the Taho, Poyang, and Tungting lakes. Accordingly, a margin should be allowed, and, from the notes given by other travellers, probably about five degrees judiciously added or deducted, should exhibit an equitable approximation to the actual average temperature of the Moyune country in the district of Kiangnan—a region producing most of the finest China green tea of commerce, and from whence our chief supplies of the best Chinese raw silk are derived.

From another source* we learn that the mean annual temperature of Canton (70·50) is that which generally prevails over the 30th parallel in China, and that the rainfall in the neighbourhood of that city averages from 68 to 72 inches. A glance at the above table, opposite the month of March, will show that whilst the highest temperature indicated is 65 deg.—or allow 70 deg. for the Moyune district—the lowest reading is below the freezing point—or say 35 deg. for the same locality. It is during this comparatively cool season, under the influence of gentle, yet frequent rains, that the tea season in China usually commences. Beginning about the middle of the month, with a variation of a few days or even weeks in widely separated spots, the harvest may continue with uninterrupted briskness until the end of June, when the thermometer may indicate from 70 to 102 deg.

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* *Vide* Archdeacon Gray's "China." Macmillan, London, 1878. Vol. ii, p. 358.

SILK.

Amongst the earliest shrubs to burst into foliage in spring is the mulberry, but its available leaf-harvest in China is not commonly much protracted beyond six weeks. During this period, in the Canton district, seven broods or hatchings—technically called "educations"—of silkworms are reported to be fed and their silk obtained; so that, as a rule, the silk harvest is begun and ended ere the serious business of the tea season has far advanced, and the bulk of both products is secured, and their manipulation well forwarded within, or very little beyond, the currency of the less scorching months of the year. It is the experience, indeed, of intelligent natives consulted by the writer, that the climate of the Chinese tea and silk districts during the spring and early summer is comparatively temperate; that the country is noted for its salubrity; and he can aver from personal observation, that the happy, thriving, well-dressed, and healthy appearance of every class with whom he came in contact during the chasericultural seasons, amply confirmed the native statements. Under these circumstances it seems more than probable that a profitable tea climate need not necessarily involve extremes of heat and wet, accompanied with fever, and perhaps premature death, to the European planter, and that the dismal remarks of some writers on tea planting in India, however applicable they may be to parts of Assam and Cachar, would be altogether fallacious and misleading if used with reference to China, Ceylon, or New Zealand.

TEA IN CEYLON.

In the island of Ceylon we glean additional evidence that the tea industry may be, and indeed is, satisfactorily conducted at a height above the sea which altogether precludes the possibility of a very high temperature or extra copious rainfall being necessary. On the estate of Abbotsford, at a height of from 4,500 feet to 6,000 feet, tea, closely resembling that produced at Darjeeling and Kangra in India, has been grown. At 6,300 feet the hybrid Assam plant flourishes; even at 7,000 feet some of the Ceylon planters have not been disappointed with their experiments; and at about 4,600 feet, Mr. Edward Heelis, a resident meteorological recorder, from observations spread over about ten years, gives the mean temperature at 66·50 deg. Fahr. The mean rainfall over the whole of the Ceylon tea districts does not appear to have yet been officially tabulated and made public, so that only the figures connected with one of them, Dimbula, can be given, which are 105·57 inches per annum. Such statistics, however, could scarcely prove of great value as coming from an island which is still in its infancy as regards the tea industry, unless accompanied by some details of practical results. These, fortunately, are not wanting. It appears from the local prints that, in 1880, about 100,000 lbs. were exported, whereas, at the close of the shipping season, on the 30th September, 1881, the tea exports amounted to 278,590 lbs. Again, at the recent International Exhibition at Melbourne, the Ceylon tea planters earned a distinguished position. They secured eleven first-class awards out of a total of forty-nine bestowed, obtaining thirty-six honours for the seventy-eight samples they exhibited. Altogether 270 certificates of merit were gained by 560 samples of tea, submitted by the various tea-producing countries of the world, a fair share of which evidently fell to the lot of our hard-working friends on that most interesting island.

TEA AND SILK IN INDIA.

That the indigenous tea of India, as grown in the gardens of Assam, Cachar, the Terai below Darjeeling, the Western Dooars, and other districts, is produced in a hotter, damper, and less healthy climate than that of China and Ceylon, cannot be disputed. The result, under such conditions of great heat and moisture, appears in very frequent flushes of leaves, and remarkable strength in the finished tea; but the penalty exacted by Nature seems to consist in a paucity of that delicate and much valued flavour which has always been so characteristic of the mountain-grown tea of Darjeeling, and of the exquisite aroma which distinguishes the finest growths of China. These remarks are not intended in the slightest degree to disparage the Indian product. Its tea has a special value of its own in its wonderful strength, a quality which has not been, and apparently is not likely soon to be, rivalled.

The elevation of the Indian gardens varies considerably. At Nainee Tal, the scene of an appalling landslip and loss of life a few years ago, tea bushes of great size have been noted at

6,700 feet above the sea level. The Darjeeling gardens are perched at a height of about 5,000 feet; in Kangra Valley tea is grown, mulberries are cultivated, and silkworms have been successfully reared, and their silk obtained, at 4,000 feet; the Dehra Dhoon tea plantations are situated at from 1,900 to 2,000 feet, and so satisfied are the Messrs. Lister, of Bradford, of the suitability of the district for sericulture, that (according to the *Scotsman* of 29th June, 1880) their agent "has offered handsome prizes to the ryots growing the best mulberries and castor-oil plants, and producing the best out-turn of silk." The Assam tea districts are only a few hundred feet above the sea, and some of the Chittagong gardens are not much above the ocean level.

Quite as inconstant are the rainfall and temperature, varying from 42 inches per annum in Kangra to 252 inches in parts of Darjeeling; and from 53 deg. Fahr. of mean in the latter, to 76 deg. in Durrang in Assam. Over the whole of the Indian tea districts, however, the annual mean of temperature seems to be 70·60 deg., and of rainfall 87·17 inches. Under each and all of these diverse conditions the tea plant thrives—of course with varying degrees of luxuriance—so it is evident every zone of elevation taking into account its aqueous precipitation, its thermal and geological peculiarities, will be found in possession of special advantages, allied to certain drawbacks, a correct knowledge of which will enable the planter everywhere in time to decide what variety of shrubs he should cultivate, which to avoid, and the sorts of tea he had best produce.

After this slight survey of the climate and other conditions under which tea and silk are obtained elsewhere, you are next invited to examine a few of the more apparent advantages which favour the establishment of chasericulture in New Zealand.

ADVANTAGES OFFERED BY NEW ZEALAND.

If inquiries be instituted, it will be found that the climate in parts of the Middle Island, particularly in the interior of Otago, is pronounced by intelligent Chinese residents on the spot, as well as by many observant travellers, closely to resemble that of the tea and silk districts of China. The inquirer will learn that the thermometer indicates from 90 deg. to 100 deg. Fahr., nearly every summer; that as high as 110 deg. have been noted not infrequently at Alexandra, and other places in the Molyneux Valley, as well as in parts of the North Island; and that the mulberry, the ailanthus, the castor-oil shrub, and other silkworm feeding plants grow luxuriantly in various districts, but notably in the province of Auckland. It will also be ascertained that throughout this charming district snow is seldom seen, except upon the mountain tops; that even slight frosts are necessarily a rarity in a land where the forests are richly evergreen, where semi-tropical fruits grow profusely in the open air, and where a wealth of magnificent flowers gratify the eye all the year round; that moderate and vivifying showers, to the extent of 47 inches, fall during 100 to 186 days of the year; that in many places* the subterranean water supply is apparently inexhaustible, and is so easily and economically tapped, that copious artesian fountains can be established for the small sum of £6; that the mean of the coldest month is 51 deg., and the warmest 68 deg. Fahr.; that the grape vine, and olive are often seen intermingled with the fences; and that the hot blighting winds and dust-storms of Australia and parts of Asia, so inimical to tea and mulberry culture, and so fatal to the silkworm, are unknown. Probably no more convincing certificate of climatic excellence could be quoted than that shown by the following table (see next page) compiled from Dr. Hector's observations.†

These are some of the advantages which seem to invite the chasericulturist to this seductive province. For convenience of comparison, the statistics given may be thus condensed:—

I. We learn that, in the China silk districts, three years' private observations gave the highest reading at 113 deg. at Shanghai, and the lowest 22 deg., mean maximum 62·66 deg., mean minimum 48·33 deg.; that a margin of about 5 deg. should be allowed as the approximate correction for the Moyune district; and that the rainfall there is gentle but frequent.

II. We find that 70·50 deg., according to Dr. Gray, is the prevailing temperature along the 30th parallel, which intersects most of the tea and silk districts of China; and that the average rainfall at Canton is from 68 to 72 inches per annum.

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* *Vide* "The Colonist," by W. Bateman, Christchurch, Smith & Co., 1881, p. 57.

† *Vide* "Hand Book of New Zealand," by J. Hector, M.D., C.M.G., F.R.S., Director of the Geological Survey. Wellington, 1879.

CLIMATE OF AUCKLAND (36·50 DEG. S. LAT. AND 174·51 E. LONG.), FROM OBSERVATIONS EXTENDING FROM 1859 TO 1879.

Months in Gt. Britain.	Months nearly Corresponding in New Zealand.	Atmospheric pressure.	Difference of mean daily extremes of temperature	Means of the seasons.	Rainfall. Inches.	Per cent. per season of rainfall.
			Fahr.	Fahr.		
February	September	0·886	15·84	Spring. 57·56	4·331	25 Spring.
March	October	0.827	16·56		3·520	
April	November	0·835	18·00		3·752	
May	December	0·657	18·90	Summer. 66·92	3·409	19 Summer.
June	January	0·681	19·80		2·071	
July	February	0·728	20·88		3·272	
August	March	0·756	19·80	Autumn. 61·16	3·150	24 Autumn.
September	April	0·909	19·08		3·402	
October	May	0·961	16·92		4·771	
November	June	1·043	15·30	Winter. 52·34	5·721	32 Winter.
December	July	1·051	15·48		5.279	
January	August	0.965	16·74		4·331	
	Mean...	0·849	17·77	Total...	47·009	100

Annual maximum temperature, mean..............88·52 Fahr.
,, minimum ,, ,, 33·26 ,,
,, fluctuation ,, ,, 55·26 ,,

III. That the early spring temperature of the Moyune tea and silk districts may range from 35 deg. to 70 deg., with frequent rains; and that a good tea climate need not necessarily be a deadly one.

IV. We glean that in Ceylon tea is grown at from 4,600 to 7,000 feet above the sea level, in a mean temperature, at 4,600 feet, of 66·50 deg. Fahr.; that at Dimbula the rainfall is 105·57 inches; and that the yield of tea has more than doubled during the last year.

V. That in India tea is produced, in gardens situated at from 30 feet to 6,700 feet above the level of the sea, under mean temperatures ranging from 53 deg. to 76 deg. Fahr., with an annual rainfall varying between 42 inches and 252 inches; that silk has been harvested at 4,000 feet in Kangra, and is being grown at Dehra Dhoon at about 2,000 feet; and that the mean temperature over all the Indian tea districts is 70·60, with a mean rainfall of 87·17 inches per annum.

VI. That parts of New Zealand, notably the province of Auckland, exhibit a climate resembling that of the tea and silk districts of China, with a temperature fluctuating between 33·26 deg. of mean minimum to 88·52 deg. of mean maximum, rarely touching the freezing-point, and mounting nearly every summer to 110 deg., having an average rainfall of 47 inches spread over 100 to 180 days of the year, and rejoicing in inexhaustible and economically-reached subterranean water supplies.

Apparently, therefore, as far as general climate is concerned, a fair theoretical case seems to have been established in favour of Auckland, as a district perhaps equally well suited to produce the hardy and best flavoured teas of China, and the less robust, although more astringent and valuable growths of Assam. If it cannot lay claim to the intense average heat and rain deluges which characterise the Indian tea localities, it may boast of being wholly free from such devastating hailstorms as those of last May, which so terribly mauled the Kumaon gardens, that their crop, according to a correspondent of the *Delhi Gazette* in October, was expected to be reduced by nearly one-half—from 2½ to 1¾ maunds per acre. The absence of sweltering heat, indeed, removes the necessity for an extra copious rainfall. In India, as elsewhere, Nature provides for the restoration of climatic equilibrium disturbed by profuse evaporation, but where, as in Auckland, the climate is remarkable for its equability, the requirements of a lesser degree of heat are amply satisfied by moderate showers, numerous streams, and a well-moistened yet rarely gorged subsoil ; all pointing to the evident advantage of even such a delicate shrub as the indigenous tea of Assam.

As yet, tea cultivation in New Zealand has not, so far as is known, been tried beyond the precincts of the Government and private gardens, but as mulberry bushes are numerous* in various parts of the islands, are readily propagated from cuttings,† thriving well, and bearing lavishly; and as the eastern apothegm which heads this essay—"Wherever the mulberry grows luxuriantly, there Nature indicates a suitable spot for tea"—may be regarded as an epitome of Chinese experience, ranging over many centuries, any illustrations which can be quoted of success in sericiculture in New Zealand may reasonably be held as applicable to tea growing also.

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* *Vide The Press*, Christchurch, New Zealand, June 6th, 1881.

† *Vide* a Review of Baron Ferd. Von Müller's "Select Extra Tropical Plants," in the *Littleton Times*, Christchurch, New Zealand, June 2nd, 1881.

PRACTICAL ACHIEVEMENTS IN SILK-CULTURE IN NEW ZEALAND.

The difficulties which attended the early experiments in silk-culture in Australia, as well as subsequent successes must already be so well known (the particulars being preserved in this Society's *Journals* of former years), that recapitulation is unnecessary. With similar efforts in New Zealand, however, there may not be the same degree of familiarity. Whilst the advocates of sericiculture in Australia were in full activity, and shortly after the formation and first meeting in London on the 18th February, 1869, of "The Silk Supply Association," the promotion of silk culture in New Zealand found an able exponent in the person of Mr. T. C. Batchelor, of Nelson. On the 8th January, 1870, that gentleman introduced the subject to the notice of the Colonial Government, and followed up his first letter by a series of communications which, with other important contributions from Dr. Hector, of the Geological Survey, and several gentlemen connected with various local acclimatisation societies, appeared afterwards in the form of a State paper.* In his letters, Mr. Batchelor pointed out to the Government, and endeavoured to arouse his fellow colonists to appreciate, the financial importance of an industry capable of yielding a return of £100 per acre. For seven years prior to 1870, this gentleman had been cultivating the Tuscan mulberry and producing silk to a limited extent; and he mentioned in one of his letters to the Colonial Secretary that four years experience had convinced him that an annual yield of even £100 per acre would indeed fall greatly short of the result he expected a few years later, when his trees had grown older. However, beyond calling attention to the suitability of parts of New Zealand for sericiculture, eliciting some interesting information through official sources, and obtaining an offer from the Government of a bonus for the encouragement of the industry, no further result of Mr. Batchelor's advocacy at that time appeared. At a later date, however, the subject was again revived, partly through the display at the Sydney Exhibition, in 1879, of some creditable specimens of cocoons and raw silk reared in Auckland and Canterbury, and partly because of the untiring vindication of the industry on the part of a few believers in this capability of the colony. Thus, Mr. Batchelor's agitation of 1870 was not entirely fruitless, as sericiculture was subsequently included among the matters for inquiry by the members of "The Colonial Industries Commission," who began and ended their labours in 1880. Their report* contained several recommendations for the promotion of sundry local industries, and some useful remarks by a Government *employé*, Mr. Federli, relative to sericiculture; but the Parliament of New Zealand seems to have as yet taken little action for the encouragement of either tea or silk cultivation, and the subject has probably been shelved for another year. This apparent apathy is unfortunate, as, under generous treatment from a sympathetic executive, chasericulture might have been at the present moment of great importance to the colony.

COST OF PRODUCTION.—TEA.

As probably the most important consideration connected with the subject, your attention is now invited to the cost of producing tea and silk in some of the districts where the industries are pursued; not as a definite indication of the probable outlay in New Zealand, but simply to serve as hints to future chasericulturists there. In China, tea gatherers receive equal to about 7d. per day;† tea porters, about 10d.;‡ chair-bearers, about 1s. 8d.§ Averaging these rates, and allowing a slight reduction on account of so many women and children being employed, the ordinary wages may be reckoned as from 8d. to 10d. per day. In India the variation is greater, as in some districts labour has to be imported, and in others where it exists, the competition of the tea planter has raised the scale from about 3 rupees per month,|| as in Assam, in 1857, to 9 rupees in 1859, and to a still higher figure there and elsewhere at the present time. In Darjeeling, it was 10d. per day in 1879; paying by results and by contract, causes an outlay of 10d. to 1s. per day; whilst, on the other hand, in Upper Assam, in March,

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* *Vide* Papers respecting Sericiculture in New Zealand, presented to both Houses of the General Assembly by command of the Governor, Wellington, 1870.

* *Vide* Report of the New Zealand Colonial Industries Commission, dated, Wellington, 29th July, 1880.

† *Vide* Williams's "Middle Kingdom." Vol. ii., p. 136.

‡ *Vide* "The Tea Districts of China," by Robert Fortune.

§ *Vide* Report on East India Finance, by a Select Committee of the House of Commons, 1871, p. 253.

|| *Vide* "Journal of the Society of Arts," March 12, 1869.

1881, the monthly rate was only 4 rupees, or about $3\frac{1}{8}$d.* per day. Brought into a focus and averaged, these figures give a mean rate for China and India of about $7\frac{3}{4}$d. per day.

With no other figures to aid the inquirer than these, the conclusion would be that India, on the whole, ought to produce tea at a less rate per lb. than China; but such a deduction is not warranted by facts, as the outlay in the latter country, including carriage to a shipping port, but excluding all barrier squeezes and export duty, is only about $5\frac{1}{4}$d. per lb. for black tea and $6\frac{1}{4}$d. for green.†

In marked contrast to these modest figures are those which the experience of India affords. Mr. Bainbridge, in this hall, on the 12th March, 1869, stated that the cost of producing tea in Upper Assam with imported labour at that time was 1s. $3\frac{3}{8}$d. per lb., and in Lower Assam, where coolies were to be had on the spot, at 1s.; Mr. Fortune and Dr. Jenkinson were quoted by Major-General Clarke as estimating the cost at from 4d. to 6d., and the gallant officer gave his idea as 9d. per lb.; Lieut.-Colonel Money‡ afterwards printed data which placed the cost at $4\frac{3}{4}$d.; the *Indian Tea Gazette* of May, 1879, supplies the particulars of the working of eleven tea companies, the average of whose productive cost was 1s. $2\frac{1}{4}$d.; and the accounts of the Assam Company for 1879, exhibit their cost per lb. to have been for that year 1s. 4d. In Ceylon the cost, as gathered from the local journals, seems to be about 10d. per lb. An epitome and average of these statistics will read as follows:—

ESTIMATE OF THE COST OF PRODUCING TEA.

In China, per Rhind, Fortune, and statements made to the writer ..	$5\frac{1}{4}$d.	per lb.
,, Upper Assam } p. Mr. Bainbridge	1/$3\frac{3}{8}$	,,
,, Lower Assam } p. Mr. Bainbridge	1/	,,
,, Kangra, per Mr. Fortune and Dr. Jenkinson	5d.	,,
,, Kangra, per Major-General Clarke	9d.	,,
,, Himalayas, Chillagong, and Neilgherris, per Lieut.-Col. Money .	$4\frac{3}{4}$d.	,,
Per 11 Tea Companies in *Indian Tea Gazette*, May, 1879	1/$2\frac{1}{4}$d.	,,
In Assam, per The Assam Company, May, 1879	1/4d.	,,
In Ceylon, per the local journals	10d.	,,

Or an average of about $10\frac{3}{4}$d.

COST OF PRODUCING SILK.

That a fair estimate of the cost of silk production may be found for a new country like New Zealand, it is desirable to avoid the usual old continental centres, where the industry, through the condensed experience of centuries, has been brought, in every item, to a pitch bordering on perfection. A suitable illustration is furnished by a recent traveller in Asia Minor,* where it is said that, in Turkestan, a peasant's family of four persons can raise on an average each season about 108 lbs. of cocoons from one ounce of silkworms' eggs, obtained from $1\frac{1}{2}$ lbs. of cocoons, and fed on the leaves of 20 mulberry trees, costing the equivalent of 38s. Should the family own the trees, the cost of food is, of course, saved, and goes to increase their profit. The result of this little venture is a total cost of 5s. $0\frac{3}{4}$d. per lb. for the 9 lbs. of marketable silk produced, or 4d. less to the mulberry proprietor, whilst the product may fetch in the European market from 20s. to 25s. per lb. Thus the ignorant Turkish labourer, notwitstanding a great waste of material, realises a profit of $6\frac{1}{2}$d. per lb., and the middleman, who purchases from him, immensely more, from an occasional industry extending over only a few weeks. Another example is to be found in the earliest achievements of the Victorian Ladies' Sericicultural Company, Australia, founded by Mrs. Bladen Neill and some of her friends, an account of which was read to the members of this Society by that energetic lady, in 1876. Experiencing many disappointments through diseased eggs, she visited the chief silk districts of Europe in search of healthy *graine*. At length a supply of robust eggs was procured in Switzerland from renovated breeds reared on the confines of perpetual snow, and from these, conveyed to Australia packed in ice, the magnaneries were re-stocked, with the result that, among the first produce were samples of silk valued in London at 40s. per lb. The cost of production was about 8s. 8d. per lb., the average of those three examples being 6s. $1\frac{3}{4}$d.

THE LABOUR DIFFICULTY IN NEW ZEALAND.

An ingenious comparison of the climatic and other statistics already given, would probably have proved sufficiently convincing as to the suitability of parts of New Zealand for the prosecution of chasericulture, even had practical achievements been wanting. When, in addition, regard is given to Mr. Batchelor's success from 1863 to 1870, and Mr. Ferderli's evidence before the New Zealand Commissioners in 1880, surely it will be allowed that the proper establishment of the combined industries there has something to recommend it. Still, it is one thing to succeed on an experimental scale, but quite another matter to achieve a pecuniary triumph in a totally new undertaking, in a new country, upon commercial lines, in the midst, and in spite of scarce and expensive labour. We have learned in a rough way something of the average wages paid in other chasericultural countries; but the fact remains unchallenged, that, in New Zealand at the present moment, the rates for ordinary unskilled European labour are several times higher. True, the quantity of work performed by the labourer in Auckland under the influence of its delightful and exhilarating climate, set against the more meagre results obtained amidst the rain deluges, the fierce heat, the scorching winds, and the terror of ravenous beasts in Assam and elsewhere in India, may, after all, be such as to minimise the apparently great difference in wages. It is true, also, that the high rate of remuneration prevalent at the Antipodes has been owing to a hitherto sparse population, combined with the vast amount of heavy pioneering work to be done; but, as the soil gets peopled, there can be no doubt that the price of unskilled work will gradually become more equably adjusted. Again, if the average individual wages paid in China are small, the total expenditure by the farmers and manipulators cannot possibly be insignificant, because comparatively little machinery, and that little of the rudest construction, is employed. The work is done; but, like the erection of Egypt's vast pyramids and other monuments of antiquity, which for centuries have taxed the ingenuity of experts to explain, it is accomplished simply by numbers, each paid with a pittance; where, with the aid of suitable machinery, a tithe of the hands in every department would suffice. Our Indian tea-planters early became alive to the value—and, indeed, the necessity—of adopting mechanical appliances, thereby enabling them materially to reduce the numbers at first employed in proportion to the work accomplished.

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* *Vide* "Indian Tea Gazette," of March, 1881.

† *Vide* "Rhind's Products of the Vegetable Kingdom," p. 393, for the basis of calculation; also communications made by natives of China to the writer whilst visiting different parts of the Empire.

‡ "The Cultivation and Manufacture of Tea," by Lieut-Colonel Edward Money, 3rd ed., 1878.

* *Vide* Eugene Schuyler's "Turkestan," London, [illegible]

New Zealand seems to be exceptionally favoured in the possession of copious and never-failing streams with which to drive machinery, and this circumstance might, through the introduction of a well-considered system of wide planting, be made almost as available in the field as in the factory.

Five sources of human labour may in time be tapped—European, Chinese, Indian, Polynesian, and Maori. The three first might, at the commencement of the enterprise, supply the necessary skill and much of the muscle, whilst the two latter went into training. Clearly, however, it would be greatly in the interests of the Government, as well as in that of the colonists, if the Maoris, being on the spot, could be induced to offer their labour at reasonable rates; and no less would it prove advantageous to the natives to earn wages at such congenial employment. Fortunately, it is not necessary that we should feel limited to the employment of Maori sinews, so long as there are many hundreds of industrious Chinese* already settled in New Zealand, whose co-operation in such industries might easily be had, whose services and experience—acquired in many cases, doubtless, at the great centres of tea and silk production in their native country—could not fail to prove of the greatest value. Resort on occasion could also be had to the importation of labour direct from China, as experience teaches that the offer of a few pence over the minute wage of sixpence, ninepence, or one shilling per day, which the Asiatic willingly toils for at home, would not remain long neglected. The difficulty, indeed, with the sons of the yellow race, has not hitherto been to induce them to leave their country for others where larger wages were to be earned, but rather to prevent them swarming like locusts, as in California and some parts of Australia, to the detriment of American and European workmen, whom they threaten to drive altogether out of the labour market. Of such a contingency, however, there is little immediate prospect in New Zealand, as the authorities there seem lately to have decided to levy a tax of £10 per head upon every Chinaman landing in the colony, which will probably have the effect of deterring all except the most industrious and most ambitious from turning their steps in that direction.

It will be evident, therefore, that the field is ample from which moderately priced labour may possibly in future be drawn, even excluding the vast human resources of New Guinea. In the thousand islands of Polynesia there exist magnificent hives of crude industry, only requiring the exercise of prudent and humane management to convert them into vast commercial wealth. Unfortunately, at present, the appearance of white men in search of labourers there is far from welcome, but a time is assuredly coming when, under benign regulations, some system of voluntary and limited servitude might be inaugurated mutually beneficial to both employers and employed. Such labour, of course, would necessarily imply more outlay than that engaged on the spot. In Assam, we have seen that imported labour adds nearly fourpence per lb. to the cost of producing tea. To counterbalance this possible charge in New Zealand, there is the duty of fourpence per lb. on imported tea, from which the native-grown article would probably remain exempt.

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* Dr. Hector gives the Chinese population in 1878, in his hand-book already alluded to, as being 4,433.

In dealing with the labour difficulty, it should be specially kept in view that, in the course of time, as the inducements to immigration for the purpose of engaging in these attractive industries become well known and appreciated, hundreds, perhaps thousands, of respectable European families will eagerly flock to New Zealand, and thus supply, not only some of the ordinary labour, but the deft manipulative skill, the discriminative foresight, and the high intelligence which chasericulture imperatively demands.

WHY THE INDUSTRIES MUST BE CONDUCTED TOGETHER.

The foregoing observations and statistics will, to some extent, have prepared the way for the statement of some of the chief reasons why tea-farming and sericiculture in New Zealand must be conducted together, for at least the first few years, in order to yield a remunerative result. It has been mentioned that in the Canton district in China, there are usually seven separate hatchings of silkworms per annum, and that the season or harvest is generally over in about six weeks. In California, where the mulberry grows with amazing prodigality—yielding during the fourth year 5,000 lbs. of leaves fit for silkworms' food from 1,000 bushes per acre, and realising net sericicultural profits ranging between £60 and £240 per acre*—the season is said to be more prolonged. In Australia, in favoured spots, it may endure for even a more lengthened period; whilst in parts of New Zealand, owing to a magnificent climate, absence of frost, and freedom from scorching winds and dust-storms, there is every reason to expect the utmost extension in point of time of which sericiculture is naturally capable. Some additional expansion of harvest time may be artificially effected by the judicious selection and introduction of other silk-producing worms besides the mulberry-feeding *Bombyx mori*—the *Attacus ricini*, which eats the leaves of the *Ricinus communis*, or castor-oil plant; the *Attacus atlas*, whose food is found on the *Terminalia* and *Zizyphus jujuba* (a worm which yields the celebrated, almost imperishable-by-wear grey Tussah silk of China and India); the *Antheræa Roylei*, which subsists upon the leaves of the *Quercus incana*, or common hill oak; the *Bombyx cynthia*, whose natural food is the *Ailanthus glandulosa;* the *Antheræa yamamai*, another oak-leaf-feeding species from Japan, whose eggs are so easily hatched, that in France incubation has been accomplished at a temperature very little above the freezing-point; and others which might be named, supplemented, perhaps, by the *Aranea maculata*, a gregarious spider of enormous dimensions, seen and studied by Dr. Walsh during his travels in Brazil, which spins a strong, golden yellow cobweb, ten yards in diameter; but after every known modification of sericiculture shall have been tried, the chief part of every year must necessarily remain unimproved to the farmer confining himself to silk production alone, on account of the forced suspension, at the end of three months, of the industry, through lack of material. Under such circumstances, it will be evident that no sericiculturist could afford to retain a full staff of *employés* in comparative idleness for nine months of the year. They must be employed in a profitable manner in some kindred industry; be permitted to revel in unproductive idleness during two-thirds of their time; or be mostly discharged until the approach of next season justified their re-engagement. In old countries, with large populations, a similar objection could not be urged, as employers there can nearly always procure a supply of willing hands. But at the Antipodes, where a skilled staff, and, indeed, all the workers would be collected together only after the exercise of considerable patience, the discharge of even a single servant, except for gross misconduct, might prove both perplexing and injudicious. Continuously, and yet remuneratively, to occupy the whole time of such a staff, then, is the problem to be solved by any one proposing to commence silk-culture on a commercial scale in New Zealand. This is the difficulty to be confronted, as it certainly is the barrier which for many years must effectually prevent this splendid colony developing into a producer of silk, should the attempt be made to promote sericiculture as an independent industry. It may be said that silk-culture is so simple, so easy, so homely an employment, that neither expensive plant nor costly labour are required; that it might be managed in an adjoining shed by the female members of every colonial family; that it might be made a cottage industry; that it might be conducted by any nurseryman; and that it could be established as an adjunct of every farm-house. Not much more than half a century ago, a similar style of fallacious logic was applied in this country to many so-called cottage industries, such as spinning yarn, weaving, the knitting of hosiery, and some other useful vocations, yet our most industrious and nimblest fingers were soon left far in rear by organisation, capital, and machinery. Rearing silkworms will probably soon be extensively practised in an amateur way by our fair sisters in New Zealand; every cottage may presently acquire its acre of mulberries, each nurseryman throughout the colony may shortly find it to be eminently profitable to strike mulberry cuttings by tens of thousands; and many farmers will no doubt speedily discover that eight tons of mulberry leaves per acre one year, and thirty tons the next, as in California, yield a profit not to be despised; but none of these efforts and results could be dignified by the name of commercial sericiculture. No such attempts with the mulberry, however persevering, are likely to culminate soon in the establishment of silk-farming as a great national industry, without the co-operation of some kindred or allied vocation, the union of which will provide work for the *employés* all the year round; and the world may be searched in vain to find one so nearly related and so well adapted to form a twin industry, as the cultivation and preparation of tea.

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* *Vide* Baron F. von Müller's "Select Extra Tropical Plants."

Unlike the comparatively limited duration of the mulberry leaf harvest, as suited to the food wants of the silkworm, the seasons for tea cropping and manipulation, beginning later, may continue for six, eight, or even nine months. Thus the addition of the tea industry to that of sericiculture provides a bridge over the hiatus left by the earlier cessation of the latter, and the union of the two promises almost consecutive employment for the whole twelve months. Again, the accession of a tea trade to that in silk will create that desideratum for every commercial enterprise—a rapid turnover of capital and a constant inflow of revenue. From the large and increasing demand for tea at the Antipodes, it may safely be reckoned that all that could be produced on the spot would, for many years to come, find an immediate sale within the colony and in Australia, and so a continual influx of earnings would gratify the planter's pocket whilst waiting the result of his silk shipments to Europe.

On the other hand, it should not be suppressed that no adequate return need be expected from a tea garden until the fourth year; that for three years such acreage would be almost unproductive of income. But as a counterpoise, the yield from a newly-formed mulberry plantation of five-year-old bushes would hardly be longer delayed than that of some ordinary agricultural crops, and after the fifth year *in situ* it would probably be doubled.

With these circumstances kept well in view, it will surely be admitted that in the close union of two such important industries there stands a tower of unusual financial strength. If a mulberry acreage produces an almost immediate return, it labours under the detriment of affording only temporary employment; if a tea area yields little for a time, it promises thereafter a busy round of duty during probably nine months out of the twelve; but the combination on the same estate, under the same chief management, gives assurance of a scene of consecutive employment, so profitably dovetailed and interlaced in the all-significant item of time, as to promote economy at every step, without the least sacrifice of efficiency or courting inferiority in the results. Once more, the prosecution of the confederated industries will undoubtedly attract a much wider range of skill from Europe and elsewhere than the pursuit of either, separately, could possibly effect, with the probable issue that, whatever the cost of production might be at the commencement of the enterprise, the outlay, as experience matured and applicants for employment became numerous, must sensibly diminish. It seems quite legitimate to expect, also, that whenever it became widely known that raw silk was being regularly and copiously produced in New Zealand, the kindred trades, arts, and professions, which in older countries cluster around all important centres of creative energy, would speedily group themselves there; the tea department would not be the last to benefit; and the Government, as well as the colonists and natives, could not long avoid sharing largely in the advancing prosperity.

SOCIAL AND PHILANTHROPIC ASPECT.

There is a certain disinclination on the part of the public to entertain proposals in which a humane element mingles with the commercial; where a desire to comfort and improve the condition of the weak and suffering is allied to the hope of producing dividends partly through their aid. Not that those elements are really considered antagonistic, but rather because, on account of some failures in former alliances of this nature, it has come to be generally believed that philanthropy and commerce are better kept separate. Without attempting in any way to combat this feeling, it is, nevertheless, desirable to ask your further indulgence for a few minutes, whilst an effort is made to reconcile the two features, as forming part of the chasericultural proposal under review.

When a commercial crisis bursts over this country, numbers of delicately nurtured and well educated females invariably suffer, being either made destitute by the loss of their patrimony, or constrained to become for a time the recipients of benevolence. Some of these, perhaps, whose natural abilities and acquirements are above the average, may distinguish themselves as governesses, public teachers, journalists, artists, in the professions, or in some other capacity; but the greater number usually contemplate a dreary future of poverty, armed with no more effective weapon than the needle. In the chasericultural operations conducted by some future syndicate in New Zealand, numerous openings will undoubtedly occur wherein females of education, as well as their less favoured sisters, may be employed, to the permanent alleviation of the miseries at present endured by many of our countrywomen. Numbers of these patient sufferers, although unable to support themselves in the old country in a becoming manner, and probably unfitted physically to cope with the muscular demands of a purely agricultural life in any colony, might prove valuable assistants in the finer manipulations of the tea-house and in the magnanerie. Such objects of compassion have not hitherto been in the demand which their real worth often merited, consequently their opportunities for immigration have generally been as limited as their chances of employment, in any colony to which they might find their way. But in a great tea and silk farming establishment many of these forlorn ones might find an independent refuge; an important measure of relief would accrue to the higher branches of female labour at home nearly always so greviously overstocked; and the syndicate initiating such a philanthropic movement would probably soon reap a well-desrved reward, in the impetus to further enterprise the co-operation of numerous intelligent and well-educated women could not fail to impart.

With the details of how such female assistants might be employed there is probably no need to trouble you, as it is doubtless well known that in sericiculture women of rank in every civilised country have from time immemorial taken a lively and often a laborious interest; and in some of the open-air as well as in-door operations connected with the production of tea in China, females of good position do not hesitate to give their services. It will probably also be conceded that no manufactured articles are held in higher estimation by the fair sex of this country than tea and silk; then why should they not have a hand in their production? If the business of furnishing those valuable products forms part of the cheerfully-undertaken duties of some of the ladies of Asia and Europe, can it be unreasonable to believe that similar vocations would gladly be welcomed and would be as aptly performed by lady emigrants in New Zealand, especially when they were assured that the industries call for no sacrifice of their womanly dignity, or the endurance of the least social humiliation. As if to encourage so desirable an object, it happens that the opportunity of gaining instruction in the mysteries of at least the silk industry, from ladies similarly situated to themselves, is not unlikely soon to be brought within reach. Along the Levant silk is largely produced under purely domestic circumstances by numbers of European ladies. An eminent member of your Society, some time ago, suggested to the writer that among those ladies may be found some English widows with daughters, left with small means, who would doubtless be only too glad to immigrate to New Zealand among their countrywomen, and in the position of superintendents in a chasericultural establishment, give practical lessons in their interesting vocation. Steps have been taken to ascertain how many British ladies may be thus situated, and it is expected that the informatior will shortly be obtained.

FINANCIAL SIGNIFICANCE.

The last phase of the present inquiry is that of the financial importance of the industries advocated, which can be seen almost at a glance by reference to the following table, compiled from the commercial reports* published by some of the tea and silk brokers of London at the beginning of this year, and from some other sources*:—

EXHIBITION OF SOME OF THE FLUCTUATIONS IN THE CONSIGNMENTS TO GREAT BRITAIN OF TEA AND SILK, FROM 1664 TO 1881; AND OF THE SILK HARVESTS IN FRANCE, FROM 1821 TO 1879.

China, Japan, and Java Tea.		Indian Tea.		China, Bengal, Persian, Brutia, and Italian Silk.		Results of the Silk Harvests in France.	
Year.	Lbs.	Year.	Lbs.	Year.	Bales.	Year.	Kilos. of Cocoons.
1664......	2	1851 .	262,839	1830...	22,741	1821...	10,000,000
1745......	730,000	1861..	1,520,000	1840 .	23,051	1831...	14,000,000
1746......	2,358,589	1864...	3,285,000	1846...	30,658	1841...	17,000,000
1784......	4,948,943	1865...	2,510,000	1852...	46,985	1846..	21,000,000
1833...	Termination of the E. I. Co.'s monopoly.	1866 .	5,133,000	1853...	54,489	1853...	26,000,000
		1867...	7,084,000	1856...	75,166		
1864......	120,284,000	1868...	8,133,000	1857...	112,757	At this period the silkworm diseases in France seem to have got the upper hand, so that the harvests dwindled as follows:—	
1868......	118,480,000	1869...	15,522,000	1859...	93,154		
1869......	145,472,000	1870...	18,434,000	1863...	80,862		
1871......	151,149,000	1871...	16,101,000	1871...	72,062		
1872......	164,502,000	1872...	17,748,000	1872...	63,832		
1873......	144,610,000	1873...	19,390,000	1873...	53,359		
1874......	139,876,000	1874...	18,374,000	1874...	52,881		
1875......	168,886,000	1875...	26,114,000	1875...	40,310	1854...	21,500,000
1876......	155,997,000	1876...	30,253,000	1876...	53,930	1855...	19,800,000
1877......	152,747,000	1877..	33,753,000	1877...	39,590	1856...	7,500,000
1878......	164,898,000	1878...	36,852,000	1878...	37,939	1863...	6,500,000
1879......	145,212,000	1879...	38,865,000	1879...	35,426	1864...	6,000,000
1880......	157,380,000	1880...	45,729,000	1880...	33,772	1865...	4,000,000
1881......	161,668,000	1881...	46,195,000	1881...	26,223	1879...	3,500,000

Assuming the gift of 2 lbs. of China tea by the East India Company, to Queen Catherine, in 1664, to have marked the begining of the now vast tea trade of this country, an examination of the above will show how rapidly it grew, and what enormous dimensions it has now attained. In a modified degree is exhibited an anually increasing consignment of tea to London from our Indian gardens. Japan tea is not figured separately, being a small and decreasing item in our market, yet deriving interest from the fact that in 1880 our American consins imported 83 million pounds of it. Java furnished us last year with 1¼ million pounds; and Ceylon, the last accession to the fraternity of tea-producing countries, exported 278,590 lbs. in 1881, after supplying all her local demands.

The silk statistics, unfortunately, depict an apparently waning industry; all the more conspicuous when viewed in contiguity with those representing tea. This decadence has been mainly, if not wholly, due to the ravages of the various silkworm maladies, which first appeared in France in 1848. Those diseases for some years did not materially affect the harvest there, as in 1853 the culminating point of prosperity was reached, when 26 million kilos. of cocoons rewarded the farmers, nor elsewhere till later, as 1857 witnessed the largest import of silk there has ever been to England, amounting to 112,752 bales. Since those days, however, the figures have, with the exception of the year 1876, been so steadily diminishing, that, should the insect maladies continue as heretofore, it may soon become safe to predict a date when the incubation of European eggs shall have ceased altogether, and the continuance of the industry be placed in considerable peril. The financial significance of such an event may be inferred from the language of M. Dumas, when in 1858 he assured the French Senate that 1,000 millions of francs (£39,583,333, at 9½d.), was his estimate of the world's annual silk harvest at its zenith, in 1853, of which France yielded one-tenth. Statistics such as these give point to the oft-repeated remark that, "it will be to new conntries like New Zealand and Australia, still uncontaminated with the germs of silkworm disease, that the silk-producers of Europe must in future look for supplies of perfectly healthy eggs."

Of these minute objects, more than 42,000 are sometimes required to weigh one ounce; and should all hatch and live their full term, the quantity of mulberry leaves devoured ere the worms commence to spin, will not have been less than 1,500 lbs., the harvest being about 120 lbs. of cocoons. Before the ravages of *muscardine*, *pébrine*, *flatcherie*, and the other minor diseases, became so extensive and refractory, the weight of the average European cocoon was about three grains, requiring 2,500 to represent 1 lb.; but not many years elapsed ere the average weight fell to 2·48 grains, or 2,817 per lb., consequently, the injury inflicted by the maladies did not halt at the extermination of immense quantities of stock, but caused a diminution to the extent of nearly one-sixth in the silk yield of the worms still able to spin. Under these circumstances, it is not surprising that sericiculturists in Europe and elsewhere have for years been looking towards our colonies for supplies of untainted eggs. The astonishing thing rather seems to be that—the demand being so great (Italy alone hatching three million ounces per annum*), and sometimes so pressing; and New Zealand so entirely suitable for this as well as the other branches of silk-farming—sericiculture, allied with tea production on a commercial scale, has not years ago been started. As illustrative of the abrupt and unexpected manner in which a demand for silkworms' eggs sometimes arises, the enormous value a single order may comprise, and the vast interests its fulfilment or otherwise may involve, the following anecdote, not six years old, may be given†:—There had been a failure in the mulberries in Italy in 1876, so that few eggs could be saved for the following season. In their distress the farmers, through their consul, applied to some East India merchants in London, and had their fears quickly allayed by the purchase in Japan by telegram of the whole quantity required. A few weeks thereafter the stock, contained in 948 cases, weighing 28 tons, and valued at over £100,000, made its appearance at Folkestone, when the valuable merchandise was immediately forwarded to Milan for distribution over the Peninsula. The loss and misery which must inevitably have ensued in the stricken portions of Italy that year, but for this timely and well managed transaction, will be readily understood when it is added that, in the single province of Ancona‡ there are thirty-three extensive silk mills, one of which—probably a fair specimen of the others—at Jesi, belonging to "The Industrial and Commercial Bank of Bologna," is driven by water-wheels of 200-horse power; has 6,500 spinning reels constantly in motion, producing annually 60,000 kilos. of silk yarn and thread; and employs over 300 operatives, chiefly women and girls.

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* *Vide* the *Annual Market Reports* published by the following brokers:—Messrs. W. J. & H. Thompson, 38, Mincing-lane, 4th January, 1882; Messrs. Layton & Co., 17, Mincing-lane, 12th January, 1882; Messrs. J. C. Sillar & Co., 21, Mincing-lane, 12th January, 1882; Messrs. Stenning Inskipp & Co., 29, Mincing-lane, 3rd January, 1882; Messrs Durant & Co., 11, Copthall-court, 2nd January, 1882; Messrs. J. B. Leckie & Co., 11, New Broad-street, 6th January, 1882

* *Vide* Art. "Silkspinners" in *London Society* for December 1881.

In the early days of a sericicultural establishment in New Zealand it would probably be this lucrative egg trade which might be most important, because, for a time, the more easily managed. The retarding process by refrigeration has for some years been working satisfactorily in Europe, and in the experienced hands of Captain George Mason, of Yateley, Hampshire, so that the eggs of silkworms can now, with perfect safety to their vitality, be sent through the tropics packed in ice, and kept for a reasonable length of time at either end of their voyage until the food of the worms is ready. There seems to be no good reason, therefore, why New Zealand should not, in the immediate future, enjoy at least a portion of the two millions sterling which Europe now annually, on an average, pays Japan for *graine*.

Little more remains to be said regarding the financial importance of sericiculture, except to refer to the marvellous accounts which, from time to time, have reached this country of the triumphs of silk-raising in California. During 1870, it was reported that between seven and eight million mulberry trees were planted. Some time afterwards the United States Commissioner of Agriculture estimated, according to Baron Ferdinand Von Müller, "that under ordinary circumstances one acre should support from 700 to 1,000 mulberry trees, producing 5,000 lbs. of leaves fit for food when four years old. On this quantity of leaves can be reared 140,000 worms, from which ova at a net profit ranging from £80 to £240 per acre will be obtained by the work of one person." A case is also cited according to which "£700 was the clear gain from 3½ acres, the working expenses having been £93." In the *graine* rearing department also, this country has made such progress that five years thereafter its eggs were, and probably are still, in constant request in Italy, where at that time they were readily purchased by hundreds of ounces at from 25 to 40 francs per ounce.

Such are a few of the more palpable circumstances which seem to favour the promotion of chasericiculture in New Zealand. There are difficulties to be encountered and the prejudices of the labouring portion of the emigrants to be overcome, but in the future there are evidently great rewards in store for the colonists who are prepared to co-operate; for the natives who may be induced to assist;

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* According to M. Bonhomme, manager of the Sonoma Sericicultural Association, California, quoted by Mrs. Bladen-Neill, at meeting of British Association, 1875.

† *Vide The Mercantile World*, of 15th March, 1879.

‡ *Vide The Glasgow Daily Mail*, 4th July, 1876.

for the Government of the period which heartily cherishes the infant industries; as well as for the capitalists who may combine to carry the undertaking through. It is surely unnecessary to linger over the subject. Enough has probably been said in advocacy of a proposal which, based as it is on facts and broad deductions, and built upon the substantial foundation of supplying an ever-increasing demand, and not flimsily reared on the treacherous sands of mere enthusiasm and speculation, can scarcely fail, if intelligently and spiritedly conducted, to achieve a measure of that success which usually waits upon most well-considered, thoroughly-organised, and energetically-conducted enterprises.

DISCUSSION.

Dr. MANN said the great practical point of the paper was the mingling of the two industries, the production of silk and tea, together; he was not, himself, sufficiently well acquainted with the facts to give any opinion upon the practicability of this suggestion. Another important contention was, that in New Zealand the climate nearly approximates to some climates where silk and tea were largely cultivated, and the point for consideration that evening was whether the conditions physically presented by nature were such as to allow the advocacy of a practical industry in New Zealand. The third point to be considered was the labour question, because to introduce an industry of this kind it was necessary there should be an abundant and cheap supply of labour. It was very questionable whether native labour could be made available for the purpose, but still New Zealand was so situated that it might not be very difficult to obtain the requisite labour from without. The paper did not profess to show that certain things had been done; it was rather a feeler thrown out to advocate a certain industry for a young colony, and some further information might be given in the discussion upon the points which he had named.

Mr. W. MARTIN WOOD said, the figures presented in the paper with regard to the temperature and the rainfall tended towards the logical conclusion that the cultivation of tea and silk could be promoted in New Zealand. He understood that a warm humid climate was requisite for tea cultivation, and that a dry climate was the best for silk; still, no doubt, those drawbacks could be overcome if mechanical appliances could be brought to bear, and the principle of mingling the two industries could be carried out. Mr. Cochran seemed to think that they could be carried on in the same district, but that was a point upon which there was some doubt. The question was not, whether tea and silk could be produced in New Zealand, nor whether it could be produced to a profit, but could it be produced to a greater profit with less risk and less outlay of capital than other industries. That question had not been raised in the paper, but that was the question which would have to be considered; and his impression was, that there were industries which might be conducted in New Zealand with much better success than either tea or silk. The grand difficulty was, no doubt, in getting the necessary labour, and, although they might by offering a proper wage, get plenty of Chinese labourers, it would be necessary for the New Zealand Legislature to alter the present law upon the point. Indian labour could not be made use of on account of the climate, but there was a very large field of labour within reach, namely, in the Polynesian islands. No doubt that stream of unemployed labour had been stopped by the outrages which had lately been prevalent amongst the islanders, but it was to be hoped the influence of the British Government would gradually abate this evil, and when the dread which had extended amongst the islanders was overcome, no doubt they would be induced to go to New Zealand. He thought more hope was to be looked for in that direction than from the distressed ladies of Northern Europe. If the Polynesians, who led a life of comparative ease, could be induced to turn their attention to work, their life in this world would be greatly prolonged, because at the present time, owing to their indolent habits, they were gradually being weeded out. Mr. Cochran had mentioned that the mulberry could be grown in New Zealand, and had referred to the number of moths which could be used in the colder climates for the production of silk; and for the information of anyone who intended to pursue this matter, he might mention that in India a new kind of moth had been successfully introduced; it was something between the *Yamamai* and the *Zizyphus jujuba*, or Tussah, which would feed on trees other than the mulberry.

Mr. C. PFOUNDES said, as he had lived in a country geographically situated for climate and soil the same as in New Zealand, and had been connected with the silk and tea industries, he might, perhaps, be permitted to make a few remarks. He was much struck with the practical bearing of the paper, pointing out the two industries which might be developed in New Zealand; and it was certain that if the New Zealand Government only showed the activity that had been shown by other colonies, before many years had elapsed, these two industries would become an important feature. New Zealand must look forward to producing the better class of teas and the higher grades of silks, because it was only by so doing that she would be able to compete with the Asiatics, who produced tea and silk by the aid of cheap labour. Having lived for many years in Asiatic countries, and as a colonist, and having friends in Australia, he must certainly say he should never stand up for the introduction of an alien and non-Christian race into New Zealand, as he believed the introduction of Chinese labour would do more harm than good to the country. One of the great things to be considered, was not the degree of rainfall, but the sudden changes of temperature, and the liability in certain districts to thunderstorms, as a thunderstorm would be likely to kill a vast number of the worms. He might mention that the Japanese Government issued illustrated cards, at a nominal price, for the benefit of the natives who took an interest in the rearing of silkworms, and he thought it would be as well if the Colonial Government were to follow this example. He had taken the liberty to bring with him three or four cards out of each set, and at the conclusion of the meeting he should be happy to explain them to the members. He did not think that New Zealand should look for labourers amongst the Polynesian islanders, the Maories, or the coolies, but rather to England, where there were many young ladies, especially fitted for the work, who would only be too willing to go out. He was rather prejudiced against any labour which was not European, and, recollecting that charity commenced at home, they should look to their own countrymen for help before seeking it elsewhere. Japanese silk was sent largely to France; and New Zealand, to compete successfully with Japan, would have to be very particular in the kind of labour employed, for if the reeling was carelessly done, there would be unevenness and broken threads, which would lower the price obtained for the silk very considerably. It was here where they could never thoroughly depend on coolie labour, for if the silk was not reeled off so as to produce a fine article, it would not fetch the highest price in the market. It would be necessary to go by steps to introduce the cultivation of silk into New Zealand, and the first thing to do would be to get the farmers to take it up. There were a large number of well-to-do colonists with plenty of leisure time on their hands, and it was to this class that they must look for the development of the industry while it was in an experimental state. He thought it would be highly desirable for the Colonial Government to collect the best information from all countries where the silk industry was carried on, to get specimens of the various kinds of worm, and to try and get skilled labour from Japan.

Mr. E. HEPPLE HALL said there were two or three points in the paper well worthy of consideration. He had not been fortunate enough to visit Australia, though he had been in China, Japan, and India; and his experience brought him to the conclusion that soil suitable for the production of the finest kinds of tea and silk would scarcely be met with in New Zealand. There was no limit to the production of tea and silk on soils such as are met with in China, Japan, and India, for this reason, that tea and silk thrived best on a comparatively poor soil. It was now admitted by chemists, that land partially exhausted was better adapted for the production of tea and silk in its highest state of perfection than rich land. New Zealand, from north to south, covered an area of over 1,000 miles, and on such an extensive surface it was possible to produce almost everything, though what seemed to thrive best was wheat. By the kindness of the authorities at Wesminster, he had obtained an abstract of trade and revenue for the last quarter of 1881 from New Zealand, and as throwing some additional light upon Mr. Cochran's paper, he might mention, that in those returns, next to gold, wheat was returned as the largest export, the next in quantity being wool. He did not know whether he was warranted in drawing special attention to these facts, except that it went to prove that in a young colony like New Zealand, with a large territory and small population, it would be better to devote the capital to the production of wheat and wool, rather than to the production of such precarious crops as tea and silk. Upon the question of labour, he might say, having visited the tea and silk districts of China, that his opinion of the Chinese, despite their heathenism, paganism, and opium smoking, was that they were useful members of the body politic, their labour being valuable wherever it was carried; and he was opposed to the prohibitive regulations which he was sorry to see were being enforced by their American friends. He agreed with Mr. Pfoundes, that, as a social question, the importation of the Chinese coolie, pure and simple, was not a very desirable thing to contemplate; but as a factor of the labour question, the Chinaman formed an important element, and therefore if they could not populate New Zealand fast enough, they should hold out their right hand to the Chinese.

Mr. COCHRAN, in reply, said that if the tea and silk industries were to be conducted at all in New Zealand, they must be conducted together, for the sake of economy, as the silk cultivation by itself would not pay, in consequence of the shortness of the season. It was true that some parts of New Zealand were very damp, but the climate of Auckland was dry; and, even if the rainfall happened to be deficient, this could be easily made up by the subterranean water-supply. He was glad to hear that a high bred moth had been introduced into India, and no doubt the experience gained there would be extremely useful in the event of silk cultivation being introduced into New Zealand. He understood from a local paper, that certain people in India were exceedingly wroth at the idea of introducing the cultivation of tea elsewhere, as it might interfere with the Indian trade; but it was very foolish to take such a view of the matter. No doubt there were different kinds of soil in New Zealand, and a poor soil would suit any kind of tea, but it was the practice of the planters in India to manure the ground very heavily, so that if they had a rich soil in New Zealand to commence with, there would be a great saving. In New Zealand, as elsewhere, you might find soil suitable for any description of tea, and it would be the object of the planter to ascertain what kind of soil was best suited for the particular kind of tea which he wished to cultivate.

Mr. HEPPLE HALL, in proposing a vote of thanks to

Mr. Cochran, said, whether England would ever receive tea from New Zealand was rather a question for the colony to settle, though no doubt discussions such as the present would go some distance to help the colony to come to a conclusion upon that point. He hoped some day to have an opportunity to visit New Zealand, when he would be able to judge of the conditions under which these industries might be carried forward. He looked upon New Zealand as a land which could be relied upon for producing the staple grains, and he hoped to live to see the day when the produce of the colony would be delivered in English ports in 30 days, and when that time arrived, he thought they would see tea and silk brought to this country from that colony.

NINTH ORDINARY MEETING.

Wednesday, February 1st, 1882; GEORGE GODWIN, F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Berens, Alexander A., 68, Great Cumberland-place, Hyde-park, W.
Brightman, Edward, Lyndale, Redland-road, Bristol.
Christie, Alexander Livingston, H.M. ship *Excellent*, Portsmouth.
Dymond, Edward E., F.M.S., Oaklands, Aspley-guise, Woburn.
Oliver, William Robert, 40, Chancery-lane, W.C.
Radcliffe, Arthur H. W., Addison-villa, Water Orton, near Birmingham.
Rolls, Arthur Frederick, Holmlea, Sutton, Surrey.
Schwabe, Frederick Salis, Rhodes, Middleton, Manchester.
Viles, Edward, Codsall Wood, near Wolverhampton.
Wilton, Robert, 24, Poultry, E.C.

The following Candidates were balloted for and duly elected Members of the Society:—

Bird, Henry, F.C.S., South Down-house, near Devonport.
Blythe, W. E., F.C.S., Green-lane, Wavertree, Liverpool.
Christie, James Alexander, F.R.G.S., Plymouth.
Cowtan, Mawer Cowtan, 309, Oxford-street, W.
FitzGerald, Gerald Augustus Robert, 11, Great Queen-street, Westminster, S.W.
Greenwood, Richard Hargraves, Bankfield, Kendal.
Guy, Albert L., A.R.I.B.A., 195, High-street, Lewisham, S.E.
Lundie, John Möller, 6, West-parade, Great Grimsby.

The paper read was—

STAINED GLASS WINDOWS; AS THEY WERE, ARE, AND SHOULD BE.

BY LEWIS FOREMAN DAY.

Glass painting may be considered from either of two points. It may be looked at as glass or as painting. Those who consider it only from the painter's point of view, never cease to lament its limitations as an art; those who contemplate it from the point of view of glass, from the decorative and more technical point of view that is, lament only its perversion into a pictorial channel. And there is this advantage in the latter standpoint, that, while the painter who dabbles in glass is all along impatient of the restraints put upon him by the medium in which he is working, the glazier welcomes the pictorial element as one more source of interest added to his craft.

Historically, the craftsman's point of view has determined the direction in which the art should be developed. The date at which stained glass was introduced into Europe, we may leave to archæologists to determine, each of whom may have his own ingenious theory on the subject. All that appears to be proved is, that as early as the twelfth century the art existed in France, if not in England, in a fair state of development. The probability is, that no distinct period can be fixed at which it sprung into existence. More likely it was the result of a species of evolution. The germ of the art was in the fact that glass was made in comparatively small pieces (there were no large sheets of plate-glass in those days), and so it was necessary, in order to glaze any but the smallest opening, that these small pieces should be bound together in some way. It followed naturally, in days when art was a matter of every-day life, that the idea should soon occur that, if these pieces must be glazed together, they might as well be arranged in ornamental fashion; and presently the principles already long in use in mosaic work became grafted into the art of the glazier, which was, after all, only mosaic of a transparent kind.

We trace the descent of glass painting, then, not from pictorial art, but from mosaic; and begin the study of it, as it began, with what is called mosaic glass. In very early windows the glass employed was always self-coloured. That is to say, the colour was given in its molten state—while it was in the pot, in fact; and for that reason it is technically called "pot-metal." I am not going to tire you with technicalities, but it will be worth while to bear in mind this one term of "pot-metal," in order to distinguish it from "enamel" colour, of which we shall have to speak by-and-bye, in connection with those triumphs of glass-painting, which marked the point at which the art began to decline.

In mosaic glass the sheets of pot-metal, or self-coloured material, were broken up into fragments, much as the slabs of marble, or opaque glass, had already been broken up into tesseræ; and these pieces of coloured glass were bound together by strips of lead, as the tesseræ of a pavement or wall picture are bound together by cement. The window is, in short, a mosaic of transparent glass. It has even been suggested that, in some of the earliest glass, the glazing is meant to imitate the tesseræ of mosaic, but an examination of the examples brought forward in corroboration of that theory scarcely affords evidence of such intention on the part of the first glass painters; rather, I imagine, that the like procedure led, in each case, to results that are not unlike.

Doubtless, the first stained windows were simply mosaics of tinted glass, the pieces framed, perhaps, in wood, or terra-cotta, or plaster, as they are to this day in the mosques of Egypt. Whether the first European examples were altogether unpainted, it is difficult to say. One finds very easily patterns of clear glass; there are some at Salisbury Cathedral, and fragments in the cloisters of York Minster; but there is nothing to prove that these are earlier than other windows that are painted. So far as we can judge, our glazing seems, almost from the first, to have been supplemented by painting. The very early glass at St. Denis, and the still earlier at Augsburg, are painted.

This painting, though it is strictly speaking enamel, is not the kind of enamel to which allusion was made just now, in contradistinction to pot-metal; that is, an enamel colour used for colour's sake. This was simply an opaque brown or blackish pigment, used to define the forms of figures and patterns, and to give minute detail.

The earliest method may be made clearer by an illustration. Suppose a glass painter, working according to the principles obeyed in the thirteenth century, were to undertake to depict, in stained glass, the map of England, he would take for each county a piece of glass of the tint he wanted, and would shape it according to the outline of the county. These pieces he would lay side by side (like the parts of a puzzle), leaving just space enough between them for the core of the lead that was ultimately to bind them together. He would then paint round the edge of each a solid black line, so that the black edge of one piece, coming against the black edge of the next, would together form a bold divisional line between the counties. (This would represent that portion of the glass which would afterwards be covered by the lead.) With the same opaque colour, he would go on to paint the lesser indentations, in the coast and other border lines, the rivers, the mountains, the cities, and the names. This done, the puzzle would be taken asunder again, the glass would be put into a furnace and burnt till the vitreous colour became fused with the glass, and finally it would be leaded together, the joints soldered, cement rubbed into the crevices between the glass and the lead, in order to make it firm and weather-tight, copper wires would be attached to the leads in places, and by these it would be tied to the iron bars let into the masonry for its support.

For some centuries after the introduction of stained glass, the only enamel used was this opaque brown or black, and it was employed solely to render the drawing of the forms. In the figure of a saint, the head would be cut out of a piece of pinkish glass, and the features only painted upon it in the opaque enamel. In foliage, the leaf would be cut from a sheet of green glass, the serrations and the veins would be painted. The colour of the drapery, in like manner, would be in the glass, the folds would be painted on it. The earliest glass painters are sparing in their use of shadow; but what shading they used was just a smear of the same brown pigment on the surface of the glass. It was not till later that it occurred to them that the accidental inequality in a sheet of glass might be turned to account, and they picked their pieces where they could, so as to get a gradation from light to dark without the aid of paint.

Of existing early glass in England there remains more in the choir of Canterbury Cathedral than in any other church in this country; some of it very fine, and all of it representative of the glass of the period.

In the design of a window, as of all surface decoration, the first thing that the artist has to determine is the manner in which he shall break up the surface before him. The early glass painters were in the habit of breaking up a window in the following manner. They began by marking off a broad border all round it, often as much as one-sixth part of its whole width. This consisted ordinarily of foliated ornament, emphasised at the edges by narrow strips of white and colour. Within this border they would then arrange a series of circles, quatrefoils, or other medallion shapes. These were, for the most part, occupied by figure subjects, the intervening spaces between them being most frequently filled with scroll work, or in Continental glass by geometric diaper. The scroll work consisted naturally of the foliated ornament of that date, based usually upon the trefoil, and seldom approaching at all nearly to nature; but there is everywhere in early English detail, and notably at Canterbury, more variety than is commonly supposed. The subjects in the medallions are invariably small in scale, too small, to my thinking, either for proportion or edification. Something, indeed, is done towards counteracting this defect by adopting extreme simplicity of composition, and defining each figure as clearly as possible against a strong blue or ruby background. For all that, in some of the most sparkling and gem-like windows at Canterbury and elsewhere, the subjects, even when they come nearly on a level with the eye, are on far too minute a scale to be made out by mortals of ordinary patience, or, perhaps, it would be more correct to say impatience. In fact, it is only the more conventionally familiar of which one at all readily discovers the meaning; and these one recognises almost by anticipation. Some of the subjects at Canterbury are not of this stereotyped character, but have reference to the life of St. Thomas à Beckett; or—as the guide expressed it—they represent "the miracles done by Thomas à Beckett after he was dead: things was taken from his shrine."

There was a very obvious reason for the adoption of a small scale in early glass work. At that time, the use of the diamond was unknown, and the only resource of the glazier was to draw a red-hot iron point along the surface of the glass, which caused it to crack approximately in the direction he desired; and he had then to reduce it to the exact shape by laboriously chipping away its edges with a kind of iron hook, which was called a grozing-iron. Simple forms were thus almost a matter of course, and the smaller they were, the less danger there was of breaking them. Naturally the smallness of the pieces of glass employed, encouraged, if it did not originate, the use of small figures.

A certain confusion of effect may be considered as characteristic of thirteenth century glass. And, when we remember, that most of this minute mosaic work has, in the course of time, suffered more or less damage, necessitating further leading, which was often done by ignorant and careless glaziers, who have recklessly misplaced portions, and sometimes put in whole subjects upside-down, we need scarcely be surprised that so much of the earliest glass is a riddle to the uninitiated. It presents, in fact, very often the effect of colour, and no more; but when it is such colour, colour is enough.

When glass like this is framed in a circular opening, or in one of those beautiful wheel or rose windows (such as we find in the transepts at Lincoln, for example), it has been compared to the patterns formed by the kaleidoscope. Nothing could have been further from the minds of the thirteenth century glass painters than any such mechanical device, for they were lavish of the thought they put into their art. Nevertheless, the result of their labour does, as it happens, charm us something in the same way that the toy amuses children, through the very vagueness of its form and the unintelligibility of its colour.

At a certain point in the enjoyment of beauty we ask for a meaning in it, and feel the want of it if it is not there. And yet, in other moods, we yield to the charms of uncertainty, of mystery, of being at liberty to put our own interpretation upon the beautiful, and to let it sway us without caring to know why. Music stands high among the arts, but we don't ask what it all means. A somewhat bolder kind of early glass is exemplified in the clerestory windows at Canterbury, where the space within the border is simply divided horizontally into two parts, in each of which sits a saint. But even this bolder work is not bold enough for its position. Really grand and imposing early figure-work is to be found mainly in the French cathedrals.

There was yet another kind of early glass which I have not mentioned, namely, those white or silvery-pattern windows which are called "grisaille." The term, though technical, explains itself. It is applied to all windows which consist, for the most part, of white or whitish glass—where the effect is delicate and grey, instead of being rich. There is a quantity of this kind of glass at Salisbury Cathedral, and much of it in very beautiful patterns; but the best known windows of this character are the five long lancets occupying the end of the north transept at York Minster, which go by the name of the "Five Sisters." From their position and size, as well as intrinsic excellence, they give as good an impression of this kind of work as could be wished. If the "Five Sisters" give you no gratification, it may safely be said that no early grisaille glass will be likely to interest you. Their size is such that the whole of the end of the transept presents itself as one huge screen of the most delicate and silvery glass. The design is with difficulty to be deciphered. In many places the painted part of the pattern has been obliterated by time; odd pieces of plain glass are mixed up with it here and there; and a perfect network of accidental lead lines (where it has been broken and mended) render it most intricate. Parts of it almost suggest old cracked china on an impossible scale. Nevertheless, with all its imperfections, and in a manner owing to them, the effect is simply perfect—something to be enjoyed rather than described or criticised. There is a legend concerning the origin of these windows, which illustrates amusingly the popular ignorance on the subject of glass-painting. Dickens tells it in all innocence, in his "Nicholas Nickleby," attributing the windows to a date at least a hundred years later than belongs to them, and speaking of them as "richly stained," though "time has softened down the colours;" whereas they are, and always must have been, delicately grey in tone; and time has only mellowed the tint, not made it a whit less rich than it was from the first.

The story tells how five maiden sisters wrought the designs of these windows in tapestry; and to this day the verger repeats the tale. I ventured to suggest a doubt to him, but he looked at me reproachfully, "more in sorrow than in anger," and I felt half-ashamed of having thrown the shadow of my scepticism across his simple faith. The fact is, that all of these designs are the natural and obvious outcome of the patterns that had been done before. Their parentage is written on the face of them. They are evidently designed by a practical glazier, and one who knew his trade, too; no lady, maiden or other, unless she had served her apprenticeship at the glaziers' bench, could have designed such glassy glass as that. To any one who recognises this glass-like character of the windows, it is wonderful how such a fable can ever have gained currency.

We have nothing in England to compare, for quantity, and therefore for effect, with the early glass to be found in the French cathedrals. It is not generally understood how very greatly the effect of glass depends upon its abundance; or rather, upon the absence of any plain windows in its vicinity. Every single ray of light that penetrates into a building, excepting through the stained glass itself, does injury to the effect of what coloured glass is there. We seldom see glass in its perfection in England—scarcely ever. For the most part, we have to form our estimate of windows under conditions which render it impossible for anyone but an artist of experience to appreciate them fairly. It is far worse than if we were called upon to judge a picture without its frame. It is more as if we were asked to appreciate a few dissonant chords of music, without knowing the harmony which they go to build. Only a musician could in the least apprehend that. And only an expert can at all appreciate an isolated fragment of stained glass, with light reflected on it from all sides. You see and admire the beauty of the windows at Strasburg, probably without realising how much their beauty is due, not only to the circumstances that there are no white windows, but to the fact that the red sandstone of the cathedral reflects so little light. The windows are seen absolutely at their best.

To be impressed with the grandeur of early coloured glass, one must go to Chartres, Le Mans, or Bourges; each of these cathedrals is a perfect treasure-house of jewels—not any of them of the purest water, but collectively as gorgeous as that Indian jewellery where stones are precious, not according to intrinsic value, but for their colour and effect. There is something barbaric about the brilliancy of this early mosaic; something that perhaps betrays its Byzantine origin. The figures are always rude, often grotesque; the design is wanting in proportion—the detail lacks grace. But the colour, where it has escaped restoration, is splendid, and there is commonly a dignity about the larger figures, for all their faults of drawing, that is little short of majestic.

It is worth a journey to Chartres and back just to spend a summer's afternoon in the cathedral. Its solemn aisles deserted by all but a few silent worshippers; no verger to hurry you on, and vulgarise the whole impression; magnificent architecture, and, all around, windows worthy of it—not just here and there, but everywhere. Many a delightful hour may be spent there, wandering about and puzzling out the patterns and the subjects of the medallion windows, till one is tired, and glad to sit down. Then you may choose a resting place, whence, on every side, the glow of distant colour falls softly on the senses. Or, one may contemplate in peace the grand array of saints in the clerestory, or the still grander kings and priests that look down from the transept windows. To sit before such colour is to be soothed and satisfied. I remember hearing of a child who sat for the first time in his life in some great church, awed by the splendour of the glass before him, when, all at once, the organ burst into music, and it seemed to him, he said, as if it was the *window that spoke.* I am reminded of that story almost as often as I see any early glass. It impresses me always, as the organ does, with its dignity, its richness, its remoteness from every day. They seem to me to strike the same deep chord; each seems to belong to the other, and both to the solemnity of the church.

"DECORATED" PERIOD.

The glass, of which so far I have been speaking, dates from the introduction of the art into England until nearly the end of the thirteenth century—and is known by the name of *early* glass. (The term "Early English," I may say, is used among architects and others to signify the art of the first Gothic period, and the common use of it, to express Old English of any date, which originated in ignorance of its first meaning, is calculated only to mislead.")

The fashion of the glass of the fourteenth century followed naturally in the wake of architecture. Already, in the last quarter of the thirteenth century, certain changes in the character of windows crept in, and soon the style called technically "Decorated" began to assert itself. The decorated style was, as its name implies, more florid than that which it supplanted. One very distinct evidence of the change was the use of natural foliage in the place of purely conventional ornament. If you find in old glass natural vine or oak leaves, ivy, or maple, you may be sure that it does not date back beyond this second period of the art.

In this century, the altered form of church windows necessitated other designs for filling them. In lieu of broad, round-headed Norman windows, or the separate lancets of Early English architecture, we have now large windows, of many tall lights, having only a slight mullion between them; and, in order to counteract the upward tendency of the lines in these windows, and to bind them together, as it were, the practice was adopted of dividing them horizontally into bands alternately of light and dark, or of grisaille and colour, any harshness of contrast being obviated by introducing into each something of the other. The coloured bands consisted, for the most part, of figure-work, the intermediate grisaille either of simple ornament or of canopies. These canopies, which had existed, in earlier work, in a comparatively insignificant form, became now a marked feature in the style—figures and figure-subjects were enshrined in niches of glass that, to a great extent, imitated those which protected the figures carved in stone or wood. This was not a very brilliant device at the best, and the ridiculous proportions to which these canopies grew, rendered it utterly absurd. The disproportion is sometimes so great that a poor little saint, of about three feet high, is overweighted with a canopy of ten or twelve feet above him. German glass sins most flagrantly in this respect, but English glass is bad enough. York Minster is richly furnished with decorated glass. The chapter-house and its vestibule are full of admirable windows, which illustrate distinctly the horizontal treatment which I have mentioned as characteristic of the period. The nave windows at York are of the same century.

Another new feature in the development of glass painting about this time, was the use of a yellow *stain;* a colour, that is to say, which was neither pot-metal nor enamel. It was discovered, about the beginning of the fourteenth century, that by applying to the surface of the glass a solution of nitrate of silver, and passing it through the furnace, a yellow stain was produced, lighter or darker, according to circumstances, but singularly clear and golden. Glass painters were not slow to avail themselves of this new method, and it became quite usual to stain the centres of white flowers, the stalks of white leaves, berries on a white ground, the hair of angels, the crowns of kings; in fact it was made use of wherever occasion offered; until in the succeeding century it became so marked a feature in the style as perceptibly to modify the design.

We need not linger long over decorated glass. It was but a link between the earlier and the later Gothic—equal in my opinion to neither. In drawing, it was little in advance of what had gone before; it failed in composition and proportion; and in colour it was neither so rich as the early jewelled glass, nor so silvery as the grisaille, either of earlier or later windows. The colour was, in fact, too evenly distributed, and lacked emphasis. Rich glass was too much diluted with white, and grisaille was so mixed with colour, that it lost its distinctive delicacy.

Examples of decorated glass are more frequent than any other in our English churches —so frequent that it would be tedious to catalogue them. In France, it will suffice to mention Troyes and Evreux; in Germany, Freiburg, Ratisbon, Munich, and Nuremburg. The windows at Strasburg are also ascribed to this date, and without doubt they were put together then; but, notwithstanding that the fashion in Germany seems to have followed slowly on the footsteps of French art, I suspect that these windows contain a great deal of much earlier glass, that was incorporated in them when the nave was rebuilt, after the great fire at the end of the thirteenth century (1298). Many of the figures of the kings in the nave are altogether early in character; and what magnificent windows they are! Every tourist knows Strasburg cathedral, but how many of you have done justice to the windows there? You were "sch . . . ed" off by an officious Swiss a quarter of an-hour before the time of closing, to wait for the performance of the clock—that dreadful clock, which forms the one subject of conversation at the *table d'hôte* afterwards, as if the cathedral had been built only to house it. And after all, it is not even a genuine old thing, but a modern antique of about 40 years ago! We have a Gog and Magog that work less shakily than that in Cheapside—but we have no such glass in London.

PERPENDICULAR.

The third and last period of Gothic glass, the perpendicular, may roughly be said to cover the fifteenth century; but it extends, in fact, over rather more than that period. Already, in the last quarter of the fourteenth century, it began to assert itself, and in the sixteenth it lingered for another quarter of a century in places where the art of the Renaissance was slow to penetrate.

It offers a complete contrast to the earliest glass, but it is none the less admirable in its way; and if it is seldom so rich and deep as that, it is infinitely better drawn, more delicately painted, more varied, and more ambitious in its aim.

The subdivision of the windows into panels containing figures under niches or canopies—which, during the preceding century, had grown to such monstrous proportions—was continued during this period, but in a milder form. These canopies were now of silvery white glass, almost in direct imitation of stonework, touched here and there with yellow stain. In the figures and figure-subjects beneath them, a good deal of colour was used, so that the effect was ordinarily that of so many panels of comparatively rich figure work framed in silvery white. An equally good effect might, of course, have been arrived at in a more satisfactory manner if some more beautiful and truly ornamental framework had been adopted instead of this ghostly pretence; but partly owing to the judicious distribution of white and colour, and partly to the silvery tone of the white glass employed, the effect was often very beautiful. There are some windows of this character on the north side of the choir of York Minster (with bishops standing under canopies and small subjects under smaller canopies below) which seem to have inspired a great deal of the modern glass affecting that period; and if we are to be content with copying (I don't think we should), they are worthy models. The immense east window at York is also of perpendicular date, and illustrates another kind of composition that was not uncommon. It contains numbers of little subjects under insignificant canopies, and shows accordingly a much more even distribution of white and coloured glass.

Among the characteristics of this style, the following are prominent. The colours introduced are less deep in tone than formerly, the blue in particular having a tendency towards grey, whilst white glass is lavishly employed, so that the general result is that the windows are distinctly lighter and gayer in effect. In many instances we have windows altogether in white and stain, or with only here and there a bit of bright colour, set like a jewel in the midst of silver and gold. By this time the artists seem to have fallen into the habit of conceiving their designs first of all as pictures, and then adapting them to glass, which led sometimes to very ingenious devices in the way glazing in these bits of bright colour, so that the lead lines might not be obtrusive amongst so much white glass. We notice here the beginning of that impatience of restraint, that dissatisfaction with the medium employed, which brought in the end such utter ruin upon the art. But, as yet, though the glass-painter first thought out his design as a picture, he did not fail to translate it into glass—and very good glass, too. A much greater variety of tints was now employed. The execution of the painting was carried much further than before, and the faces, which were studied from the life, were often full of character, and modelled as far as was consistent with the translucency of glass. Drapery, too, was not only well modelled, but disposed in careful, and even graceful, folds. Light coloured robes were diapered with rich patterns, usually in yellow satin, which had all the appearance of white and gold damask or of gorgeous brocade. It happened that ruby glass (and some blue glass) was not, like other pot-metal, coloured throughout, but only a veneer of ruby on a white ground; and the late Gothic glass painters took advantage of this circumstance to abrade or grind away this coloured surface, where need was, and expose the underlying white, so that white on ruby, or ruby on white, was obtained without connecting lead work. The white could, of course, be stained, so that yellow on ruby was equally obtainable. Certain kinds of blue glass were also susceptible of stain, which produced on it green of various shades. Every device, in short, was adopted which would lead to more elaborately pictorial results.

The windows at Fairford, in Gloucestershire, are perhaps better known than any other late Gothic glass in England; but, fine as they are, they scarcely deserve that supreme notoriety. Some years ago a theory was propounded that they were designed by Albert Dürer, but it found little favour among artists, for it left out of account the fact that Dürer was among the greatest draughtsmen that have lived, and that the figures on these windows are not even well drawn. Indeed, they are not up to the standard of the glass of the period. On the other hand, the story of the Flemish origin of the glass is borne out to some extent by internal evidence.

These Fairford windows owe much of their charm to their almost unbroken series, to the quality of the glass itself, and to the tone attributable to time. The singularly beautitul tone of the white glass, so variously stained with green and grey, is due to the fact that it is encrusted on the outside with all manner of minute lichen, which gives it this peculiar variation. The windows are said to have been buried for a time out of the way of the iconoclasts, and it may be that their burial hastened the decay of the surface of the glass, and so encouraged the growth that adheres to it. But this is speculation. Among the finest windows here, are those in the clerestory, which represent the persecutors of the Church; but, being higher up, and less easy than the others to study, they scarcely get the attention they deserve. That portion of the west window which remains intact is also fine. It represents the Last Judgment; the left hand (our right, that is) showing the flames of hell, with grotesque devils dragging off their victims into it, is not only interesting from its quaintness, but very splendid in colour. The Gothic draughtsman (particularly of this period) seems to have delighted in the portrayal of evil spirits. Here, at Fairford, the little tracery openings above the persecutors, where so frequently, in glass of that period, angels occur, there are appropriate little devils instead. They haunted my memory for some length of time after I saw them, not as anything very terrific, but as bits of beautiful colour. That seems to be the key to the delight which the mediæval painters took in dragons and devils, and hell-fire itself. It affords scope for colour—and they revelled in it. I could give a long list of the devils that have interested me in old glass—black, and brown, and purple devils, dancing in the midst of ruby flames, with beads of white eyes that look cruel, carnivorous white teeth, or yellow tusks; devils that are themselves apparently red hot; devils that are green and grey, having an iridescent but unholy kind of beauty; devils blue, and beautiful enough to scare away from the beholder blue devils less tangible that may have had possession of him.

For the most part these crude conceptions of the powers of ill impress us moderns, apart from their colour, as simply grotesque. Yet they were, doubtless, very real to the men who drew them; and sometimes there is a grimness about them that is impressive even to us. I remember a subject in a church at Louvain, I think, representing some legendary story of the struggle of a woman with a fiend, which was full of tragic energy. It set one wondering who was this poor creature wrestling in the arms of the evil one? did she escape? or was she dragged down? At all events she made a fight for it, and our sympathies go with her.

In the rendering of the subject of "The Temptation" at Fairford, the tempting serpent has the head and bust of a woman, not very beautiful, but the slimy tail below, grey-blue changing to palest green, is beautifully opalescent in colour. The notion of paradise in the background is quaint, with its architectural features and trim little fountain. It suggests rather a mild form of beatitude. It is characteristic of old glass, up to the very end of Gothic times, to attempt impossible pictures. "The Creation" was always a favourite subject, and the difficulty of pourtraying the division of the light from, the darkness, the separation of the earth from the sea, and so on, was often very ingeniously solved, though not altogether in a way that would commend itself to us. The Creator, for example, is sometimes represented as a venerable Pope with crimson robe and a crown on his head. In a church at York, is one of the most daring designs that was ever put into glass. It illustrates an old Northumbrian poem, called the "Pryck of Conscience," and boldly undertakes to show "the fishes roaring," "the sea a fire," "a bloody dew," and finally, the "general conflagration of the world."

But enough has been said of these quaint conceits of our forefathers—and enough for the present of glass of the perpendicular period.

RENAISSANCE.

We come now to the Renaissance—to glass of the sixteenth century, or, as it is termed, the cinque cento.

Seeing that the perpendicular style lingered in many places until well into the sixteenth century, it is not surprising that Renaissance glass has much in common with it. In many respects, the cinque cento glass only carries further the traditions of the latest Gothic work. In fact, unless there are some details of costume, architecture, or ornament, to guide one, it is often impossible, with certainty, to ascribe a subject to one period or the other. It is mainly in the detail and in the further point to which realism is carried, that the difference of style betrays itself. I need scarcely be at the pains to describe to you the difference between Gothic and Renaissance ornamental detail. The contrast between Henry the Seventh's Chapel, at Westminster, and St. Paul's Cathedral, is marked enough to be obvious. I wish I could refer to some equally familiar but more characteristic example of the style of the cinque cento than St. Paul's, which is more than a century too late. But we are not rich in examples of the purest Renaissance architecture in this country, nor have we much good glass of the period to boast of, though the large windows at King's College Chapel are attributed to Holbein. There is a good window, too, at St. George's, Hanover-square, which might be studied with advantage by impatient wedding guests pending the arrival of the bride. In France it abounds, and notably in some of the smaller churches of Rouen. In this French glass there is no very great deviation from Gothic precedent. The same pictorial effects are sought, and by much the same means; only the stone mullions of the windows are taken less into account in the design, and it became more and more customary to fill a window with one large subject running through all the lights.

In Flemish glass the departure from the traditions of the art is more marked. Many of you, I daresay, know the famous windows in the Chapel of the Holy Sacrament in the Cathedral at Brussels, and the two large windows at the ends of the transepts which belong to the same period—1540-7, &c. In these windows we have, in place of the Gothic canopy, a grand altar-like structure, having a central arch, the effect of which is represented in deep shadow; against it, dependent wreaths of stain and colour sparkle like gold and jewellery. In front of this altar is the subject, the figures over life-size, and through the deeply shadowed archway we get glimpses of distant country, painted on the grey blue glass (which represents the sky), in a manner that is marvellously delicate. The figures stand out in strong relief against the distance. Indeed, there is a relief of the objects in these windows that surpasses anything that had been done before; but it is arrived at by a sacrifice of glass-like quality, which, though we may condone it here, in consideration of such grand results, led inevitably to the decline of the art of glass painting. Pictorial glass could go no further than this, and it could never have gone so far, without losing some of the translucency proper to a glass window Relief and realism are arrived at by the abuse of deep shading—shading which after all is not natural; for the deeper the shadow painted on glass, the more opaque it must be; while in nature the deepest shadows are the most transparent; and all the while, this effect of shadow might have been most properly arrived at by the use of deeper coloured glass.

The attempt to carry pictorial art still further in glass was afterwards made, but with less success. Artists resorted to the use of enamel as a means of representing local colour, and the result was ever weaker and washier. The most remarkable of these later efforts are to be found at Gouda, in Holland, a famous cheese depôt, with a famous series of windows, but apparently not much frequented by our countrymen. In the street you are gaped at as a curiosity; women beckon their neighbours to come and have a look at you, and the children follow you about. At the inn they scarcely seem to expect you. You sit down to table with old ladies, in wonderful caps of lace and gold, who smile benignly on you, but can't express their friendly sentiments; dinner is an experience. In the church the vergeress, when you at last succeed in understanding what she means, pats you approvingly on the back; and the verger, when you offer to tip him still a trifle on your third visit, explains that he has already had enough and is satisfied!

It is worth a pilgrimage to the Groote Kirk, at Gouda, to see how far pictorial representation can be carried in glass, and at what point it fails. I must confess that feats are accomplished by these Dutch painters which I should have thought to be impossible. The design of these men deviated little from that of their predecessors, but they dared more, and they did accomplish wonders. In some of these immense windows, in which a single subject is represented, the architectural background is so really put before you that you almost fancy yourself looking *through* the window into distant aisles and corridors.

Some of the landscapes are not less startlingly clever. In one window is represented the "Relief of Leyden." In the foreground a *mélée* of citizens and soldiers; and, beyond, a distant view of a flat Dutch landscape. Past ships, and villages, and distant spires, the eye travels on to the far horizon, above which, enclosed within the arched head of the window, is a clear blue sky, ending with just a few white clouds at the top—all of which ought never to have been attempted in glass;—but it is wonderful how nearly the attempt succeeded. Fortunately for those glass-hunters who, in the study of languages, draw the line at Dutch, an explanation of the windows in English is to be purchased on the spot; and very wonderful and amusing English it is. It explains, however, the meaning of the subjects—often obscure enough, and tells us the names of the artists, as well as of the donors of the various "glasses," as it calls them. It appears that they were the gifts of sundry kings, princes, governors of the Netherlands, corporations of cities, and nobles, all of whom, in doing honour to the church, did not neglect the opportunity of glorifying themselves. In almost every window numerous shields of arms occur, more or less excellent in drawing and colour, but sometimes curiously mixed up with Bible subjects. The introduction of heraldry into church windows was nothing new. During the fourteenth century, it was already a common custom thus to advertise one's ancestry, in presenting a window to a church; and to this day it is not unusual to find the arms of the donor conspicuous on a church window. A very favourite expedient is to put into one of the principal tracery lights an angel bearing his shield. Yet there is certainly something incongruous in thus associating the symbols of Christian faith and of worldly pride. Pride of race may be all very well in its way, but there is an absurdity that approaches the profane, in the idea of an angel doomed to bear the arms of Mr. Smith, good man though he may have been. But this is by the way.

After the middle of the seventeenth century, good glass painting may be said scarcely to occur, excepting certain Swiss domestic panels to which I have not time to refer. It became more and more like abortive picture painting, and less and less like glass. The difficulty of leading increased with increasing desire for pictorial results; and, in despair I suppose of unravelling the problem, they cut through it brutally, and leaded up the pictures in big square panes of glass, without regard to details at all. Examples of seventeenth century glass are not far to seek, in which most delicately painted hands and faces are cut straight through by lead lines. This is a reduction of the art to absurdity. It is clear that either all delicacy of painting was superfluous, or it deserved more tender treatment than that.

No better illustration of the insufficiency of merely pictorial art in glass could be given than is afforded by the windows in the antechapel of New College, Oxford. Here are seven huge windows, filled with the original early perpendicular glass, and one large window by Sir Joshua Reynolds.

EXAMPLES OF BOTH.

Now, the glass painters of 1386, or thereabouts, were not Sir Joshuas, and certainly the painters of these old windows at New College were immeasurably inferior to him in all that goes to make a picture. I have said that before the fifteenth century the figures in glass were seldom much to boast of as drawing, but here they are even more monstrous than usual. The heads are, in some cases, twice the size of nature, and the feet and hands are flattened out more like botanical specimens that have been pressed in a book than anything in human anatomy. There is little grace or dignity about the individual figures, and, perhaps, there is not a single form that could be called beautiful. On the other hand, the forms that Reynolds drew, could scarcely fail to be refined and graceful, and, though, in the upper part of his window (which represents the Adoration) he is not at his best, some of the Virtues which occupy the lower part of it, exhibit all the tenderness and grace of the master; and yet his window is as conspicuously a failure as the Gothic windows are successful! Why is this? Simply because the designer of the older windows was a glass painter, and knew what he was about, whilst the first President was not a glass painter, and didn't. He was altogether at a disadvantage with this great window-space before him. He neither realised the difficulties nor knew the resources of the art in which he was dabbling, and in the competition with men who were his inferiors in all but the fact that they knew their trade, he was nowhere. He attempted, very naturally, what was easy to him in oil, impracticable in glass, ignoring all the while what might have been done; and with all his labour, and the skilful execution of the glass by Jervais (who, by the way, was a china painter, and went to work as if he were painting on opaque porcelain instead of glass), the effect is quite feeble. Admitting all the merit of individual figures, the fact remains that the window has no more brilliancy or beauty of colour than a big transparency. It might just as well have been painted on linen.

The Virtues (even Horace Walpole called them Sir Joshua's washy Virtues) are not nearly large enough in treatment for the spaces which they fill (or should fill, for they don't do it); a mass of heavy, opaque, colourless, and uninteresting background stares you in the face, or if the sun shines very brightly, you see instead, a mass of foxy brown; and in the upper half of the window this preponderance of heavy shadow is the chief thing noticeable. Add to this that the enamel employed in order to obtain this objectionable obscurity, is already peeling off in flakes, leaving patches of dazzlingly pure white where they have least business to occur—and you have a picture of a complete fiasco. Now, in the older glass, in spite of the most rudimentary forms of figure drawing, the artist has known how to turn the material and its resources to full account. There is a certain largeness in his treatment of the figures that gives his saints a dignity the Virtues lack. Deep rich colour is introduced in plenty, and wonderful skill is shown in the way in which it is introduced. Colour is balanced against white, and white against colour, with the dexterity of an experienced craftsman. He has availed himself to the utmost of the beauty of the material, never obscuring it by heavy paint. He has striven for colour, which he could get rather than form, which was beyond his reach; and he justifies all his faults, whether of taste or drawing, by the success of his work on glass. It fits its place, and adds to the impressiveness of the architecture: the effect is sufficient —what more can you ask? The marvel is, how Sir Joshua, in sight of these grand windows, could have allowed his own work to be put up—or, at least, to remain there. But that is a wonder that occurs nearly every time one sees a modern window side by side with an old one. All we seem able to learn from old work is to caricature its forms: we miss its spirit and its colour. It will not be worth while to mention instances of this miserable modern mock mediævalism—they are only too abundant. But I must not omit to allude to another kind of modern glass which errs in the opposite direction, though not exactly in that of Sir Joshua's unfortunate efforts. I mean what is known as Munich glass. The revival of glass painting fell, in Germany, into the hands of artists; of draughtsmen, at all events, and men, moreover, of some thought and culture. It was not likely that men of the calibre of Cornelius would be led away into the affectation of crude thirteenth century draughtsmanship. The rudeness of early Gothic art revolted them, and they rejected it altogether. With the chaff they threw away much wheat, no doubt; but, whatever their shortcomings in art, they knew how to draw, and they could not bring themselves to pretend incompetence. They knew something of anatomy, and they could not lay under their learning. So they set themselves to draw their best for glass, and some of their designs are worthy of all respect. Unfortunately, these men knew as little about glass as Reynolds did, and they based their design, accordingly, on the art in which they had some experience, viz., *fresco*. It might have been anticipated that, since they worked on the lines of fresco, and Sir Joshua on those of oil painting, their work would have been as far superior to his as fresco is more nearly allied to glass painting than oil painting is. But it must be remembered that the Germans (of the last generation, at all events) were not colourists; it is much if their paintings are respectable in colour, and the strong tones of glass were altogether too much for them. Whilst Sir Joshua lost all the translucency of glass in shadows (which in his pictures he knew how to make so transparent), the men of Munich contrived to lose all glassiness in a glare of the crudest, cruellest colour. The tints they employed were as flat as those they had used, with more excuse, in fresco. They were as even as manufacture could make them; bright without brilliancy, gaudy without richness. The windows had all the appearance of cheap coloured lithographs magnified. You may say that it is after all a question of individual preference, whether we like best form or colour. But remember, colour is the only excuse for stained glass. Glass affords opportunities for a brilliancy of colour which no other medium offers, whereas it does not lend itself at all to refinement of form, and if form is what is wanted, any other medium would do, not only as well, but better than glass. There are some important Munich windows in Glasgow Cathedral, which I have not seen, and some in the cathedral at Aix-la-Chapelle, which I have twice seen, and have no desire to see again. There are some failures in our own St. Paul's too. But if you wish to compare pretentious modern Munich with good old German glass, you have only to stand in the nave of Cologne Cathedral, and look from one side to the other. The contrast between the two is all the greater, that there is some similarity of scale and general design between them.

The old examples, on the left as you face the choir, have unfortunately suffered restoration, and some of their beauty seems to me to have been restored away since I saw them some years ago. They are not perfect. They are not equal in colour to the best glass at Rouen, nor in drawing to that at Brussels; but they combine something of the glowing colour of the one with no little of the grand design of the other; and, for all their restoration, they remain magnificent windows, among the finest examples of late Gothic glass painting extant.

To turn from these to the windows opposite, is, without metaphor, a shock to the eye—such as one suffers sometimes when, on a moonlight night, one finds oneself suddenly within the radius of the naked gas jets of a butcher's shop. The merits of Munich glass are as obvious as the conveniences of gas-light—but its demerits are equally glaring—and there are no practical advantages to make amends, as in the case of gas.

Revival in England.

The revival of glass painting in England, as in Germany, is of comparatively recent date, and may be almost within the memory of some of my hearers.

It was as a manufacture rather than as an art that it began to lift up its head. There was in England no King Ludwig of Bavaria to patronise it. No famous artist patted it on the back. But the Gothic revival was a proof that there were plenty of persons interested in ecclesiastical art. Clergymen naturally vied one with the other in the desire to embellish their churches; rich donors were not wanting, architects were nothing loth to bestir themselves in the matter, and, of course, manufacturers were forthcoming who were prepared to undertake anything and everything in the way of stained glass, if only there was a fair margin of profit attached to it. Happily, among those manufacturers, some were artists; happily, too, they took up stained glass before they had made their names; they identified themselves, therefore, thoroughly with glass painting, and won a well-merited reputation in conection with it. The element of trade brought with it, as always, an influence for good and evil. For good, in that it encouraged the art, and made it possible for men to live by it; for evil, inasmuch as the consideration as to what would pay prevailed too often over the knowledge of what was best. An artist's true success is when his conscience whispers to him that it is well done. Commercial success, on the other hand, implies, in many instances, an increasing deafness to the voice that tells us what is right. Men are but men; and it is hard to go on striving after what you know to be best, when there is no appreciation, and no fair price for it; and all the while there is clamorous demand, and lavish payment offered, for what you could do so easily, though you feel that it is not worth doing. Some of those who were artists yielded, and those who were not, knew no better; and most of our fine churches have been vulgarised, more or less, by windows that are as tawdry in their way as the trumpery decorations of wax and tinsel, and paper flowers, that desecrate the altars in the churches abroad.

But with all this, it may truly be said that modern English glass painting has progressed. It was based from the first upon a truer appreciation of the principles applicable to glass painting, than any foreign glass painters have attained to, and the best of our windows want only the effect of age upon them to be referred to by the coming generations as fine examples of old work. There is not the least doubt in the world that much of the charm of old glass is due to the effect of age upon it. If you take the trouble to examine any old glass closely you will find that much of it is, through partial disintegration, pitted and specked all over with irregular little holes which render the surface quite rough, and this uneven surface not only causes variety in the depth of the colour according to the thickness or thinness of the glass that is left, but by refracting the light that is transmitted through it, gives to the glass a quality which no even material could possibly possess. In comparing modern windows, then, with old, we must not forget what is due to time. There is a popular idea that the art of making ruby and other glass has been lost. That is a superstition. The whole art of glass painting was lost, if you like—or, more properly speaking, left in abeyance—for something like a couple of centuries; but glass is now manufactured in England that is all that the artist could desire; and if modern English glass painting is not all that it might be, it is less the fault of the glass painters than of the public, who prefer to pay a price at which moderate merchandise can be turned out, rather than a sum which would remunerate an able artist at the rate of art. The old glass we admire was designed, and often painted, by men who were among the foremost artists of their day. The great part of ours is manufactured at a price; and if, sometimes, the manufacturer gets a good price for it, the draughtsman may think himself happy if he earns six pounds a-week, whilst the average glass painter earns much less. Considering the present prices paid for pictures, even of the second and third rank, it is not wonderful that Sir Frederick Leighton and all the forty do not rush into glass painting. The only artist of independent note as a painter, who has devoted himself to any extent to glass painting, is Mr. Burne Jones, and his glass is worthy to be named with the best old glass. It proves him master of his material as well as of colour. It is unlike any old glass that ever was done, but none the less, it obeys the principles followed in old work, though it borrows none of its forms. In attempting to fix the position of glass painting in England at this date. I should say that we have men among us who could perhaps produce windows as good as anything that has been done; but until artists have been tempted to take up glass painting as they do other painting, executing their own work, or seeing it executed under their own supervision, and receiving payment for it at the rate of art, good work must continue to be scarce among us. Glass painting is not easier than painting on canvas or paper that it should be thought so much less valuable. The mediocrity of so much modern glass is due to the fact, not that we couldn't do much better, but that we are not encouraged to, and can't afford to do our best. In tracing thus far the history of glass painting, from what it was to what it is, I have forestalled what I had to say concerning what it ought to be. I think I have already suggested, by implication, at least, what stained glass should be. It should be on a level with the art of our time; but first, and before all things, it should be glass. That means to say that the artist should have studied old glass, as a painter studies the old masters. He should know what was done in the Middle Ages, and during the Renaissance, and how and why it was done. But he should not stop there. He should beware when he digs among the ruins of the past, lest any speck of its deadly dust get into his eyes, and blind him to the possibilities of the future. The archæologist is often so bigoted, the glass-painter so mechanical, the artist so ignorant of glass. We want the three fused into one—a man who is at once familiar with old work, master of his craft, and accomplished artist; a man, too, well versed in the art of the past to ignore it, too skilful to blunder, too conscious of his own power to be the slave of his knowledge; a man who is experimenting always, but basing his experiments on experience, and proving his deep reverence for the great men gone before, by daring, as they dared, to be himself.

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks to Mr. Day, said he had given them a most admirable paper, containing a lucid description of the characteristics which marked the various periods in the history of this art, and a broad and catholic opinion with respect to the two principles which governed all works in stained glass. Whilst he had enforced the truth that stained glass must first of all be a window, he had not shut his eyes to the very fine works of art which had been produced in the period of the Renaissance, even though it was too pictorial in style. His allusions to different specimens must doubtless have awakened in the minds of many present, as they did in his own, reminiscences of visits in early days to the glorious glass of Strassburg, Bourges, Chartres, Canterbury, and Fairford. He had derived more pleasure from a few days inspection of glass, than from the remarkable series of pictures in Fairford Church, and to him it would not be very difficult to accept the notion that Albert Dürer had something to do with some of them; but that was a point which had been very much discussed, and he would not enter upon it at that time. There were in some windows pieces of colour which could never be forgotten. Those who had entered Milan Cathedral at the west end, and noticed the window at the east end under a particular aspect, could never forget the effect of the wonderful pieces of colour. It was too far off for form to have any effect, but the colour was all-sufficient. Mr. Day had very rightly dwelt on the fact that while good colour would make one condone badness of form, no drawing would condone bad colour. He had also given a very useful hint as to the injury inflicted on stained glass windows by the letting-in of ordinary light by the side of them. He (the Chairman) constantly went into churches and saw a stained glass window with a white glass window on each side of it, which entirely destroyed the effect. This was never thought of; people set on foot a subscription, employed a first-class glass painter, and put in the window, but never cared about the effect on those who went to see it. He not only agreed with what Mr. Day had said as to modern stained glass, but went further, and lamented the waste of money, and the enormous mass of simple rubbish which had been put up in England during the last 20 or 30 years. He saw the record, week by week, of the windows which were put up, and believed that £50,000 a year would not be an excessive estimate of the amount spent in stained glass; that, multiplied by 30 years, came to a million and a half of money, the greater part of which had been absolutely wasted, and he had no doubt that some day most of these windows would be displaced to make room for something better. He did not wish for a moment to disparage certain firms in England, who produced most excellent glass, and could, no doubt, produce much better, but on the whole, the glass put up of late years in England was abominable. There was no difficulty in getting together two or three hundred pounds to put up a window to the last incumbent, or the last verger, or the last anybody else, but no thought was given to having it of artistic quality. A glass painter was asked to send in a sketch, and the committee decided to have a window costing so much money, but they would be astonished if they were asked to pay for the drawings from which the painter was to work about as much as the whole window would cost. But, until they were prepared to do that—until they recognised that if they would have art they must have artists, and that artists must be paid, it was quite certain they would never be anything fit to look at in the shape of stained glass. Even if they were prepared to pay, it was not every artist who could paint a window. Colourists were not made, they were born, like poets, and were not over plentiful. To his mind, the Society of Arts, though it had worked zealously at science and commerce, had somewhat neglected the fine arts of late years, but it would make up for any laxity in that respect, if from that evening's proceedings some movement could be originated, which should produce an improvement in the stained glass windows of England.

The SECRETARY said he could not of course presume to differ with the Chairman, but he did not like to hear any fault whatever found with the Society without some attempt to defend it. He would therefore remind the meeting that during the last few years they had started a School of Art Wood Carving, which was now prospering, under the auspices of the City guilds. For several years past they had had at least one course of Cantor Lectures devoted to art, in every session, and several papers on art subjects at the ordinary meetings. If members of the Society, and others, would come forward, and assist the Council by providing other suitable papers on subjects of applied art, they would be welcomed. He was sure that neither the Council nor the officials would object to being reminded of their duty by an old member of the Council, but he wished to point out that if so much attention had not been paid to Art as to Science, still Art had not been altogether neglected.

Mr. HOLLIDAY said he had attended to this subject more as an artist than a historian, though it was not possible to do even that without learning something of the different styles and their dates. He cordially agreed in the view that nothing could be greater folly than for an artist of one period to be harking back to the style of some former time. It would seem too absurd to need condemnation, but for the fact that such seemed to be the common practice, judging from the amount of money spent on stained glass, and the general notion that if a window were to be put into a 13th century cathedral or church, the window must be designed in the style of the 13th century. He wondered what a 15th century artist would have said if he had been asked to design a window in the 13th century style, or what Albert Dürer would have thought of such a request. Every artist was bound, when designing a work of art, to do the very best he could, and to do that which was perfectly natural to him; unless he did, he was like a man imitating the manners and graces of childhood, because childish innocence was a beautiful thing. So it was, and so was 13th century glass, and no one knew better than the artist, who scorned to imitate the defects of drawings of the 13th century. No art would ever be great unless the artist was prepared to devote his best powers and knowledge to it; and the artist in glass must, at the same time, always bear in mind, that he was not painting a picture, but a window; and it must be a window in its natural place in a wall; not something which made you fancy you were looking through it at a beautiful landscape. Artists ought to thank both Mr. Day and the Chairman for the way in which they had enforced on the public their duties towards the artist, but he had thought it more becoming in him, as an artist, to say a word on the duty of the artist himself towards the public.

Mr. CHRISTOPHER COOKE thought it very desirable that stained glass windows should be protected with wire to prevent damage, and mentioned two places in Cornwall, at St. Neot's and St. Michael's Mount, where there were some fine specimens of glass.

Mr. PFOUNDES asked if there was any probability of one of the designs on the wall, which was called modern Japanesque, was ever likely to figure in a church or other ecclesiastical building, since it possesssed certain characteristics which hardly fitted it for such a place of honour. He proceeded to criticise the design in detail, pointing out that it was evidently the work of someone totally ignorant of Eastern art, as it contained a mixture of Chinese and Japanese features, a plant which he would defy any botanist to classify, and above all, the female figure which formed the principal feature, and which the designer no doubt intended for a Japanese saint or princess, wore a head-dress which was only in vogue amongst a certain class of women in Japan which he would not further specify.

Mr. LIGGINS said, like other travellers, he had noticed in different cathedrals the magnificent colour of the old glass, and it appeared to him that the modern glass was vastly inferior in quality to the ancient; but he must at the same time confess, when he looked at old windows, such as those in the Church of St. Etienne du Mont, in Paris, he could not admire the designs there exhibited, nor could he admire the 1386 design in New College, Oxford. They conveyed to his mind the idea that the window had been broken by mischievous boys throwing stones, and that the fragments had been picked up and put together as well as they could, to preserve the old glass. No artist would paint towers and pinnacles without any shadows or reflections of light, and without any possible or useful design. He took exception to the way in which designs were cut up by iron bars; on the table was a specimen which he supposed represented an ancient example, in the days when it was impossible to make glass larger than a few inches square, and then it might be necessary to build up a design of small pieces; but now, when plate-glass could be made of almost any thickness, and 20 or 30 ft. square, he could not see the necessity for cutting figures into two or three in that way. It destroyed the whole effect of the design, and that might be partly the reason why stained glass was not more appreciated. If manufacturers and artists would unite to produce a better result, the art might advance, but in two new churches, one at Bournemouth, and the other the parish church of Kensington, the largest and finest church which had been built in England for some years, there was modern stained glass simply imitating that of four or five centuries ago. He should have been glad if some information had been given of a very fine window in St. George's Chapel, Windsor, which he much admired, and which was really a picture on glass; he believed it was the work of a German artist.

The CHAIRMAN said the window referred to was the work of Messrs. Clayton and Bell.

Mr. TREWBY was glad someone had spoken plainly on this subject, and protested against some of the absurdities often seen in stained glass. Mr. Day had spoken very strongly against anything in the shape of a picture, but some of the finest specimens he had ever seen of painted glass were the windows of Peterhouse Chapel, Cambridge. They were in the Exhibition of 1862, and so far from glass painting being an unremunerative employment, he should think it must be highly remunerative, for each of those windows cost £800, and there were nine of them. They were the work of Munich artists, and they were bought by the fellows of Peterhouse in order that such fine specimens should not be lost to the country. Anyone could sit in that chapel and admire those windows, for they were actual pictures, not monstrosities formed of scraps of glass, stuck together like a kaleidoscope.

Mr. DAY, in reply, said he did not wish to say anything against the Fairford windows, which he enjoyed very much, and was thankful to the artist who produced them; but he rather objected to their being considered the best examples of the period, which he did not think they were. With regard to the Japanesque design, it was the work of the late Mr. Burroughs, and was the outcome of the modern desire for new fashions. The artist was commissioned to do a Japanese figure for a window for the Paris Exhibition, which was exhibited in the Princess's Boudoir in Gillow's pavilion. He did not suppose the artist pretended to know anything about Japan, aud simply did the best he could. With regard to the remarks of the last two speakers, he thought he had made it pretty clear that he was no advocate for what he might call archæological designs being copied. He had not been able to see the windows in Peterhouse Chapel, but if they were anything like other Munich windows which he had seen, he had no doubt he should have gone away with a shudder. Colour was not a matter you could argue upon; you could simply feel it. You could not prove that such a combination of colour was right, any more than you could prove that a symphony of Beethoven's was beautiful to a man who preferred a negro melody. Mr. Liggins showed an extraordinary ignorance of glass painting in proposing that windows should be painted on large sheets of glass. If he or any other gentleman was prepared to show that without leads, and without little pieces of glass, you could produce an effect of colour superior to the old windows, he should be the first to say he was an artist indeed. But the beauty of the windows he so much admired at St. Etienne and elsewhere was owing to their being in little bits of glass. They could not, as things stood at present, be so beautiful in colour, unless made up of those little bits which he so despised, and the leads which disfigured the designs, more or less (but which were more striking in the cartoon than in the actual window), were the price one had to pay for that beauty of colour.

The vote of thanks was then put and carried unanimously, and the proceedings terminated.

Miscellaneous.

FIRES IN THEATRES.

The following extract from a paper read before the Scientific and Mechanical Society of Manchester, by Mr. C. F. Courtney, C.E., has been sent by the author, as an answer to the proposal for extinguishing fires in theatres by means of perforated water pipes. (See *ante*, p. 224.)

The late disaster at Vienna has caused the theatre-going public to again consider how they could best escape if fire should occur during a performance, and it is well, perhaps, to look the matter straight in the face, and admit, although many statements have been made to the contrary by those responsible for the safety of the public in our places of amusement, that from some one part or another, and generally the gallery, it would be absolutely impossible to escape under the present circumstances from fire on a full night. No theatre can allow of space for a staircase or sufficient width to insure a safe exit from its gallery; so cramped are they for room, that in many instances the gallery exit has to be brought down to the basement of the building, and rise again to join the pit exit, a most fatal fault in construction.

However quickly and effectually water may be applied, it gives but small chance to the lives of many. In repeated instances, before the fire has a firm hold, hundreds are trampled to death. It is the exit that must be attended to. Lines of pipes round each tier of the auditorium, and continued to the stage, perforated, and worked in sections with valves at convenient places, would but saturate the entire theatre every fortnight, in testing alone and preventing corrosion: no valve will work after standing disused for a few years. Tanks extending over the whole area of the top of the building do not work when required. Those who have charge of the supply rush to the best place of safety; and they rest upon the carcase, or exterior walls—a danger to the firemen, notably at Covent Garden a few years ago. It is the exit that must be attended to. To many of our theatres a verandah extends over the footway. Where this is not the case one could he built; no more obstruction is experienced from this arrangement than from the lamp posts. If then the columns to such verandahs be increased in diameter, so as to carry a wrought-iron flooring to each tier, an exit would be at once supplied, and might be made of sufficient size to take the number of people from such tier. The entire theatre would be cleared at once into the street and out of danger, and time would be gained in this manner to extricate them from their position. No unsightliness need be occasioned from such a construction, the fact of art in metal-work being quite established—indeed, an improvement would be noticeable in the exterior of some of our theatres, whilst having columns reared next the front corresponding to those on the kerb, the whole structure would stand independent of the flaming building,

Correspondence.

THE HALT, THE LAME, AND THE BLIND, IN UNDERGROUND RAILWAYS.

Of the yearly seventy millions of passengers who use the Metropolitan Underground Railways, it may be estimated that ten per cent., or seven millions, are afflicted with one or more of the following maladies, which are increased by using stairs :—gout, rheumatism, or asthma, or lung or heart disorders, or lame, or crippled, or blind, or paralysed, or old age—so that they find it very painful to descend and ascend steps more or less difficult.

Those at the Mansion-house have high "risers," and there are many of them especially irksome.

A large number of invalids are prevented altogether, through the stairs, from using railways.

Parcels and luggage seem more carefully cared for than human beings on railways. Mechanical contrivances make such bodies to descend and mount up, without jolt or damage—but not so mortals.

There are offices in the City, near the Mansion-house, where lifts are always moving upward and descending. Why not adapt them, with modifications, to railways, with or without increased payment, for the convenience ?

The Council of the Society of Arts have appointed a committee to investigate the subject, and ascertain what can be done.

HENRY COLE.

February 1st, 1882.

NATURE AND ART.

It is curious in these æsthetic times to note the narrow views taken by men of science regarding art, their notion of it seeming never to go beyond diagrams, maps, or photographs, things most useful in their way to argue from, though little better than texts or transcripts.

Your correspondent, Mr. Sowerby, cannot do without conventionalism, pleading as he does in the name of

Flora. The greatest poets and artists have all sought to conventionalise nature, and art in its palmiest days delighted in abstract renderings so far from the natural objects, that it is often difficult to recognise the original. In Oriental countries, where nature is the most prolific, both in form and colour, conventionalism dominates. Egypt is full of it, the sphynx being a grand mythical beast, difficult to mal-place, even as posed on the embankment, smelling the needle of Cleopatra. Obelisks ought to end a vista, or occupy an open space, and never were intended for a parapet wall. Guarding the entrance to a zoological garden, sphynxes would be *apropos*, even more so than a genuine beast, even by a Landseer, who might suffer by the comparison with nature; a conventional image never can. Witness the conventional Assyrian bulls, so full of dignity and strength, the animal, as it were, growing out of the stone; and the works of the Greeks, who gave us the most perfect images of the god-like. Their architecture was purely conventional; they delighted in centaurs—grafted the man and horse by uniting the lumbar regions of the one on the shoulder blades of the other. True art covers all impossibilities, creating satisfaction in what is seen.

Few things are in worse taste than a flower carpet on a floor, or indeed the direct imitation of flowers on or in any applied material—even including the marvellous work of a Gibbons. Roses and lilies on rails and garden gates savour of a false Chinese taste that Chinaman would hardly be guilty of. The historian and history painter should be true to nature, when depicting what has happened; they should not indicate bulrushes on the banks of the Nile, even on the authority of the British Bible. Poetry is, however, another thing, any combination being admissable that does nor violate certain laws of construction, harmonies of colour, or appropriate fitness—an appropriate fitness that will enhance and not compete with the beauties of natural surroundings.

A picture can never be a diagram or a diagram a picture; the subject-matter of a diagram may be made into a picture by the addition of pictorial effect, and yet lose all its scientific value. Art is one thing and science another; the artist may gain much from the man of science, and the man of science might obtain both repose and pleasure by the contemplation of works of art, not so much as a scientist as an æsthete.

JOHN LEIGHTON.

Regent's park, January 30, 1882.

CAUSES OF BAD TRADE.

I felt it impossible to further occupy the time of the meeting at the late hour at which I was called upon after the reading of Mr. Brown's paper, so I reserved what I had to say, and herewith embody it in writing. I wished to point out that want of technical education among both the workmen and (though, perhaps, in a lesser degree) the masters in this country, is one potent cause which has injuriously affected our trade. If fluctuations in the prices of iron and the development of railway enterprise have coincided with corresponding fluctuations in trade, certainly it can hardly be denied that the trade of our foreign competitors has advanced, *pari-passu*, with their advances in technical education; and to judge from the signs of the times, the advantages derivable therefrom are likely to make themselves more and more felt hereafter. We are only beginning now, as it were—thanks in some part to the initiative of the Society of Arts—to bestir ourselves in this matter, and unfortunately we are but doing so as yet in but a half-hearted way. Look at Germany, with all her grand schools for technical and scientific instruction in every part of her Empire; observe her valuable and incessant contributions to the advancement of chemical science. Are we not bound to conclude that it is to the great diffusion of technical knowledge that fine preparations of such great purity are produced in Germany at such low prices and so abundantly. The German comes here, and buys from us the althracene of our coal, while, carrying it home, he returns it to us at an inconceivably higher price, transferred into alizarin, and that at prices with which we cannot ourselves compete. There is hardly a pharmaceutical chemist throughout Germany but ekes out his waste time in the preparation of extracts, essences, alkaloids, dye-stuffs, or other preparations, with which scarcely an English manufacturer can be found to compete. Years ago this was not so. It is chiefly since the development of technical education in that country. In respect of France, we suffer from a somewhat like competition, only there it is not, perhaps, so much the scientific superiority of the masses that is driving us out of the field over there, as the artistic superiority of the French. France has not as yet disseminated scientific knowledge throughout the country as Germany has, while artistic culture is more to the Frenchman's taste than the harder facts of bare science. Both science and art are, however, now-a-days, intimately linked to every kind of manufacture, and while cheapness and purity are found in the productions of scientific manufacture, preference always lies—quality being the same—with those where artistic excellence is displayed. Doubtless other causes, such as over speculation, bad harvests, wars, &c., may have been potent in their effects, that of sufficient technical education should not be forgotten as one among other primary causes of trade depression must surely be admitted on all hands.

F. MAXWELL LYTE.

Obituary.

PROFESSOR THOMAS EDWARD CLIFFE LESLIE, who held the office of Examiner in Political Economy for the Society of Arts from 1874 to the present time, died on Friday, the 27th ult. The following particulars of his life are obtained from the *Times* :—He was of Scotch descent, but was born in Ireland, being the second son of the late Rev. Edward Leslie, Prebendary of Dromore and Rector of Annahilt, in the county Down. On leaving Trinity College, Dublin, he entered at Lincoln's-inn, and was in due course called to the English bar, but his early appointment to the Professorship of Jurisprudence and Political Economy in the Queen's College, Belfast, and his strong proclivity to literature, soon led to his abandonment of the law, and he became a contributor to some of the leading quarterly and monthly reviews. In 1870, Leslie published "Land Systems and Industrial Economy of Ireland, England, and Continental Countries." He had for many years entertained the design of treating the whole field of economics from the historical point of view, in a complete treatise. Unfortunately, the MS. which he had prepared was lost by a singular accident while he was travelling on the Continent, in 1872. He had since striven, in spite of failing health, to reproduce and complete his work, and an article on "The History and Future of Interest and Profit," which appeared in a recent number of the *Fortnightly Review*, is understood to be a specimen of the treatise. In 1869, he was appointed examiner in political economy in the University of London, an office which he held for the usual term of five years. Some years since he received the honorary degree of LL.D. from the University of Dublin.

Notes on Books.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. By Silvanus P. Thompson, B.A., D.Sc., &c. London: Macmillan and Co. 1881.

The rapid progress which the science of electricity has made during the past few years has had the effect that books—especially elementary books—on the subject, of comparatively recent date, have been rendered, if not obsolete, at least incomplete. The increased number and importance of the practical applications of the science have induced the attentions of a larger number of investigators, and the natural result has been, that the knowledge of electricity has far outstripped that possessed by students of any branches of physics less obviously fruitful in practical results. This was the case, even when telegraphy and electro-plating may be said to have formed almost the only applications of electricity, much more is the fact noticeable, now that not only the scientific but the general public is so intent on the problem of electric lighting. This consideration may be taken to justify the addition of one more to the long list of text-books on electricity, and very possibly it may have been in the author's mind when he undertook the task of preparing these "Lessons." The first three chapters of the book deals with frictional electricity, magnetism, and current electricity. The fourth chapter, "electro-statics," treats of the theory of potential, electrical units, specific inductive capacity, the phenonema of discharge, &c. "Electro-magnetics" form the subject of the next chapter. Following this comes a chapter on measurement, and another on "Heat, light, and work, from electric currents." In this last is included a brief account of the electric light. Short chapters on thermo-electricity, and on electro-optics come next, and after these a chapter on induction currents. The remaining practical applications of electricity are treated in the last two chapters of the book, "Electro-chemistry" and "Telegraphs and Telephones." In an appendix a series of problems and exercises is given.

General Notes.

SUBMARINE TELEGRAPHS.—It is estimated that the total length of submarine cables in the world is 62,100 miles. Putting the average cost, including stations and vessels, at £643 12s. a mile, we get a total value of nearly £40,000,000 (forty million pounds).

PROFESSORS OF FRENÇH IN ENGLAND.—The first session of the *Congrès National des Professeurs de Français en Angleterre* was held on the 12th, 13th, and 14th January. The meeting on Thursday, the 12th, was at Merchant Taylors' School, that on Friday, 13th, at St. Paul's School, and that on Saturday, 14th, at the Society of Arts. M. Antonin Roche was elected President, and M. Pagon Vice-president of the Executive Committte appointed for the ensuing year. It was decided that the meeting for next year should be held at Oxford.

WASTE PRODUCT.—Distillers' wash, which has hitherto been a source of annoyance, polluting water-courses, or rendering the soil putrescent, has been turned to account by MM. Gaillet and Huet, for the production of a valuable artificial manure. The wash, immediately it leaves the still, is treated with perchlorate of iron, after being agitated with lime water. The lime precipitates the sesquioxide of iron, the ferric precipitate taking up nearly all the organic matter. The wash thus becomes a perfectly clear, colourless, and innocuous fluid. The deposit, or precipitate, is agglomerated into cakes, and forms a manure very rich in nitrogen and phosphoric acid, which more than pays the expenses of the process. Little space or labour is required, most of the operations being performed automatically.

EXHIBITION OF ANEMOMETERS.—The Council of the Meteorological Society proposes to hold an Exhibition of Anemometers at the Institution of Civil Engineers, 25, Great George-street, on the evening of March 15th next. The committee are anxious to obtain as large a collection as possible of various patterns of anemometers, either full size, models, photographs, or drawings. Special interest will attach to all apparatus bearing upon the history of anemometers, and to their modification and improvement.

BORDEAUX EXHIBITION.—An Exhibition of Industrial and Agricultural Products, Industrial and Ancient Art, is to be opened at Bordeaux, on 1st June next, under the auspices of the Philomathic Society, with the concurrence of the Government, the Municipality, and Chamber of Commerce of Bordeaux. The Exhibition is limited to the productions of France and her colonies, Spain and Portugal. Special buildings will be erected in the middle of the town, on the Esplanade des Quinconces; and motive power will be provided gratuitously. Diplomas of honour, gold, silver, and bronze medals, and honourable mentions will be awarded by an international jury.

NEW TELEGRAPH.—Adjutant-Major Gaumet, of the 27th Regiment of France, has invented an instrument called the "Telelogne," for signalling from a distance. As experience shows that familiar objects are the most easily distinguished, the signals consist of the letters of the alphabet and figures, which are silvered on a dead black ground, and illuminated at night by lamps and strong reflectors. A powerful telescope alone constitutes the receiving instrument. For signalling to a distance of two and a half miles, the whole apparatus weighs under five pounds; and with a more powerful telescope signals can be distinguished eight miles, and even farther in a clear atmosphere. For exploring new countries, this invention is likely to prove of great service; for instance, the different members of a surveying party may be directed from a central point.

THE PATENT OFFICE.—During the past year the number of applications for letters patent has been 5,751, being an increase of 234 upon those of the year 1880. The records of the office show a steady and tolerably regular increase in the number of applications from the year 1852, when the Patent-law Amendment Act came into operation, down to the present time. In that year the number was only 1,211, but that was for a portion of the year only, the following year showing an advance to over 3,000, which, however, subsequently fell off; but by 1862 the number had risen to 3,490. During the following decade the progress was not quite so marked, the number for 1872 being 3,970. In 1876, the number was 5,069, the highest then reached; but there was a falling off of 120 in the succeeding year, since which time the numbers have risen to the figures first given as being the return for 1881.

PHOSPHATE OF LIME.—A rich deposit of phosphate of lime has been discovered about four miles north-east of Apt, in the department of Vaucluse, France. In the principal layer, bones, in ill-defined masses, are found near together, while they are farther apart and better preserved in a stratum of sand, immediately below the first deposit. Both over and under the phosphate of lime and sand, are strata of green sandstone, above which are different calcareous stratifications, mingled with shales, lignites, shells, &c. The bones belong chiefly to the pachydermata, and also to hyenas, crocodiles, birds, and a kind of river pig. Specimens have been sent to the museums of Lyons, Montpelier, Toulon, Marseilles, and also Munich.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 8.—"The Manufacture of Ordnance." By Colonel MAITLAND. Sir FREDERICK BRAMWELL, F.R.S., Chairman of Council, will preside.

FEBRUARY 15.—"The Art of Turning." By P. W. HASLUCK.

FEBRUARY 22.—"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON.

MARCH 1.—"The Teaching of Forestry." By Colonel G. F. PEARSON. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., will preside.

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 7.—"Notes on the Trade Capacities of Newfoundland." By E. HEPPLE HALL.

FEBRUARY 28.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Moscow.

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

FEBRUARY 23.—"Photometric Standards." By HAROLD DIXON. Dr. A. W. WILLIAMSON, F.R.S., will preside.

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

FEBRUARY 17.—"The Depreciation of Silver as it affects India." By J. M. MACLEAN.

MARCH 17.—"Village Life, and the Village System in the Bombay Presidency." By W. G. PEDDER.

[There will be no meeting on March 31, as previously announced, but one will be held on May 5 instead.]

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Second Course will be on "Recent Advances in Photography." By Captain ABNEY, R.E., F.R.S.

LECTURE 2, FEBRUARY 6.—The effect of the spectrum on the different molecular forms of the silver haloids. Practical applications. Sensitisers considered. Sensitiveness of the different salts of silver. Sensitometers considered.

LECTURE 3, FEBRUARY 13.—Dry plate processes. Instantaneous pictures. Instantaneous shutters. Enlargements, direct and otherwise produced. Colour of developed prints. Applications of photography to science.

LECTURE 4, FEBRUARY 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Capt. W. de W. Abney, "Recent Advances in Photography." (Lecture II.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. R. Jasper More, "County Boards."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Joseph Boult, "Uniformity in Building and Sanitary Regulations."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C. 8 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Grant Allen, "An English Weed."

TUESDAY, FEB. 7... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. E. Hepple Hall, "Notes on the Trade Capacities of Newfoundland."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. G. McKendrick, "The Mechanism of the Senses." (Lecture IV.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Dr. Paget Higgs, "Candle Power of the Electric Light."

Pathological, 53, Berners-street, Oxford-street, W. 8½ p.m.

Anthropological Institution, 4, St. Martin's-place, W.C., 8 p.m.

Biblical Archæology, 9 Conduit-street, Hanover-square, W., 8 p.m. Rev. W. Houghton, "The Birds of the Assyrian Records and Monuments."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. St. George Mivart, "The Classification and Distribution of the *Æluroidea*. 2. Mr. W. A. Forbes, "Some Points in the Anatomy of the Indian Darter (*Plotus melanogaster*), and on the Mechanism of the Neck in the Darters (*Plotus*) in connexion with their habits." 3. Prof. P. Martin Duncan, "Some Recent Corals from Madeira."

WEDNESDAY, FEB. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Colonel Maitland, "The Manufacture of Ordnance."

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. W. Hulke, "Descriptions of some Iguanodon Remains, Indicating a New Species, *I. Seeleyii*." 2. Prof. Joseph Prestwich, "A Peculiar Bed of Angular Drift on the High Lower-Chalk Plain between Didcot and Chilton."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Annual Meeting.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

THURSDAY, FEB. 9...Telegraph Engineers and of Electricians, 25, Great George-street, S.W., 8 p.m. Mr. H. F. Joel, "The Pilsen Arc Light."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. J. Perry, "Spinning Tops."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. R. Phené Spiers, "A Roman Palace."

Royal Institution, Albemarle-street, W., 3 p.m. Professor H. N. Moseley, "Corals." (Lecture IV.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. Professor W. G. S. Smith, "Note on the Formulæ for the Transformation of Elliptic Functions."

FRIDAY, FEB. 10...Teachers' Training and Registration Society (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m.

Royal United Service Inst., Whitehall-yard, 3 p.m. Mr. W. Topley, "Geology as applied to Military Purposes."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Frankland, "The Climate of Town and Country."

Astronomical, Burlington-house, W., 8 p.m. Annual Meeting.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakespeare, University College, W.C., 8 p.m. 1. Rev. M. Wynell-Mayow, "Hamlet's Speech of some dozen or sixteen lines." 2. Dr. F. Landmann, "Shakspere and Euphuism: Euphuism an adaptation of the Spanish Guevara."

SATURDAY, FEB. 11...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Annual General Meeting. 2. Dr. C. R. Alder Wright, "On the Relations between the Electro-motive Force of a Daniell's Cell and the Chemical Affinities involved in its Action."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Pauer, "Ludwig van Beethoven." (Lecture IV.)

Journal of the Society of Arts.

No. 1,525. Vol. XXX.

FRIDAY, FEBRUARY 10, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PHOTOGRAPHIC EXHIBITION.

The Exhibition of Photographic Appliances will be kept open till February 25th, every day from ten to four, and on Wednesday evenings from six to ten. On Monday evenings the Exhibition will be open to those attending the Cantor Lectures.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

Persons not members of the Society, who are interested in Photography, may obtain tickets on application to the Secretary.

A catalogue of the exhibits was issued as a supplement to last week's *Journal*. Separate copies can also be obtained, price 6d. each.

On Thursday, the 16th inst., a demonstration of Photography with artificial lights will be given. The lights available will include electric lamps, a large gas burner, magnesium lamps, &c.

Mr. Van der Weyde has kindly undertaken to illustrate the process of portraiture by the electric light, after which opportunity will be given to any who wish to do so to experiment with the different lights by taking photographs.

Amateur and professional photographers who wish to bring a camera should apply to the Secretary for a ticket. Members of the Society and their friends can obtain admission in the usual manner.

CANTOR LECTURES.

Captain Abney, R.E., F.R.S., delivered the second of his course of Cantor Lectures on "Recent Advances in Photography," on Monday, 6th inst. The effect of the spectrum on the different molecular forms of the silver haloids was described, and various points connected with sensitisers, and the sensitiveness of the different salts of silver were dealt with. The subjects treated also included the lighting of photographic dark rooms. The lecture was illustrated by means of the electric light, obtained from a Siemens' dynamo-machine (lent by Messrs. Siemens Bros. and Co.), driven by an Otto gas engine (lent by Messrs. Crossley Bros.).

The Lectures will be printed in the *Journal* during the summer recess.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tueaday, February 7th, 1882; B. Francis Cobb, Treasurer of the Society, in the chair.

The paper read was—

NEWFOUNDLAND: PAST, PRESENT, AND FUTURE.

By E. Hepple Hall.

It is a fact no less significant than remarkable, that the least known member of Great Britain's colonial family is the very one which is situate nearest to her own shores. Standing as she does, in the midst of the North Atlantic ocean, in a chief pathway of the Empire, and separated from the mother-land by little more than four and a half days good steaming, the subject of our paper is practically not further from us than British Honduras, the Bermudas, or even than Barbadoes itself. Indeed, it was not until steam craft began to cross and re-cross the Atlantic, between British, Canadian, and American ports, by way of the banks of Newfoundland and the Straits of Belle Isle, that the great majority of Englishmen became aware of even so much as the existence of such a country. To most people it was a veritable *terra incognita*, while to very many of even the best informed among us, it was as completely *terra nova* as it was to Cabot and Cortereal, when they first sighted it from the decks of their tiny craft, just four centuries ago. It was as little known to the rank and file of the British taxpayer as No-man's-land, Cockatoo-land, Wrangel-land, Wonder-land, or any other semi-supposititious and wholly undefinable place; as if, in short, it belonged to some fourth-rate foreign power, instead of to her gracious Majesty Queen Victoria, and did not figure in the British Board of Trade returns at all. Steamship and telegraph lines have helped greatly, in late years, to dispel this ignorance respecting the island. It is not, however, by any means wholly removed. The delusion which has so long held possession of the popular mind, that the banks of Newfoundland and the island itself were identical, apparently still survives in some quarters. It is sometimes referred to in text and reference books as forming part of Canada, while in more than one recently published encyclopedia it is omitted altogether. The impression is even now far from uncommon among stay-at-home folk, that the island is nothing more than a huge sand-bank, colonised in some places, possibly, but if so, only during a part of the year, and then by a sort of nomadic, floating population, who pass most of their time in catching and curing cod, and in drying and mending their nets. The belief still extensively prevails that when the island is not covered with snow, it is shrouded in fog, alternately cloud-capped, and mantled in mist—a moist, dismal, dreary, dripping, Atlantic Gibraltar, inhabited mainly by seal hunters and fishermen, and smelling strongly of fish, seal skins, and seal oil. So much for ignorance, superstition, and traditional prejudice. How far this picture of the island is fanciful, and how far it is true, my paper is designed to show.

The prevailing opinion of Newfoundland among Englishmen is certainly not shared by those living there. They are proud of their island, despite its drawbacks, which are not few; and they love it with an ardour which not even the climate, moist as it is, can damp. Their patriotism has passed into a proverb. Even new settlers soon become as loyal as natives of the soil, and never tire in recounting its attractions. Life there has compensations and endearments which are not suspected by strangers, and which the denizens of sunnier climes wot not of. This is all the more remarkable when we consider that the Island of Newfoundland is not only the nearest, but it is also the oldest of the British colonial possessions. It also occupies the position—without a parallel, I believe, in colonial history—of entire freedom from debt. It will be my privilege and pleasure to picture the settlement to you divested of all these illusions, delusions, and fallacies, and to present it to you, as far as possible, in its true colours.

The first or historical portion of my subject may properly be divided into three periods—ancient, intermediate, and modern.

Newfoundland was discovered by Jean and Sebastian Cabot as long ago as the reign of Henry VII., in June, 1497. It is still a matter of dispute whether the palm of discovery belongs to Jean Cabot, or to his son Sebastian. Sebastian, being a mariner—which his father was not—would seem to have had charge of the expedition, and therefore to be fairly entitled to the distinction, though history has not accorded it to him.

This Jean Cabot was an Italian by birth, and a native of Venice, who had for some years been settled as a merchant in Bristol. From that port, early in May, 1497, Cabot sailed in the good ship *Matthew*, in an attempt to reach India westward, as Columbus had done five years before. The first land in the New World sighted by the adventurous navigator, as proved by contemporaneous authority, was the easternmost point of the Island of Cape Breton, which now forms part of the present province of Nova Scotia. Thence he steered north-westerly, coasting the island of San Juan, now Prince Edward's Island. From this along the Labrador coast and the north coast of Newfoundland, he sailed homeward through the Straits of Belle-isle. On Cabot's map Belle-isle was delineated as a group, but the fact remains that he was the discoverer of the island. In 1498, another patent was issued to John Kabotto, Venetian. The discovery brought him into notice, but failed to confer more substantial benefit. In the records of Henry VII.'s privy purse expenses, under date 10th August, 1497, is an entry to this effect, "To hym that found the New World, £10." The last entry, dated 25th August, 1505, is a reward of 13s. 4d. to Clays, for going to Richmond "with wild catts and popingays of the New-found Island." In the year 1498, Cabot made his second voyage, in which, attempting to find a north-west passage to Cathay, he reached the latitude of 67° 30 N. On a subsequent voyage he sailed as far south as the latitude of Cuba.

Upwards of a century elapsed before any attempts were made to follow up the discovery of Cabot, in the way of colonising Newfoundland. The Portuguese were the first to turn attention to it. Within seven years of Cabot's discoveries, the Newfoundland fisheries were known to the hardy mariners of Brittany and Normandy. As early as 1517, forty Portuguese and Spanish vessels were engaged in the cod fisheries. Sixty years later, according to Hakluyt, the number of vessels engaged in this industry had increased to 400. Of this number only 50 were English, the remainder being French or Spanish. Newfoundland, however, was on the eve of a great change; its isolation was about to terminate. In 1583 England awoke to the importance of formally taking possession and planting a colony on the island. In that year Sir Humphrey Gilbert, a Devonshire knight, provided with letters patent from Queen Elizabeth, landed at St. John's, and took possession in his Sovereign's name. Sir Humphrey's expedition consisted of five vessels. the *Delight*, the *Raleigh*, the *Golden Head*, the *Swallow*, and the *Squirrel*, witb 260 hands, and a total capacity of 410 tons. The incorporation of Newfoundland with the English realm dates, therefore, from 1583. In 1610, Mr. John Guy, also a merchant, of Bristol, under a patent from James I. to the Plantation Company, and five years later, Captain Richard Whitborne, of Exmouth, visited the colony. These visits, however, appear to have resulted in little beyond the publication, in 1622, by the latter, of a "Discourse and Discovery of Newfoundland trade," which King James, by an order in council, caused to be distributed among the parishes of the kingdom "for the encouragement of adventurers unto the plantation there." In 1616-23, Sir George Calvert, afterwards Lord Baltimore, planted a colony at Ferryland, 40 miles northward from Cape Race, but under the repeated harrassments of the French, he abandoned the colony, and went to Maryland, where he founded the City of Baltimore, the commercial metropolis of that State.

Notwithstanding the earlier and continued importance of the Newfoundland fisheries, which attracted large fleets of vessels annually to its shores, the settlement of the country was exceedingly slow. In 1650, nearly a century and a half after its discovery, Newfoundland contained only 350 families. These were distributed in 15 small settlements, chiefly along the eastern shore of the island. The policy of the British Government of that day was to perpetuate the island as a fishing station, and the fisheries themselves as nurseries for British seamen; settlement and development were therefore equally retarded. The effect of this restrictive policy is seen to this day in the comparatively limited progress made towards developing the resources of this fine island, and in settling the fertile lands of the interior. Immigration of every description was discouraged in every possible way. The hostilities which existed both before and subsequent to the passing of the Treaty of Utrecht, A.D. 1713, proved another great barrier to the march of progress. Interminable disputes have arisen regarding the interpretation of this treaty, which are still as far as ever from being settled. This important State document is as clear and forcible in its wording, and as definite in its provisions, as any such instrument can be, yet it is held by the French to confer rights which its framers apparently never intended. As a consequence, the fine lands of western Newfoundland are still a wilderness, and its mineral treasures are untouched. But a brighter day was even then about to dawn. In 1728, the imperial policy was reversed, and Captain Henry Osborn was appointed first governor (civil government was established at this time). The beneficial result was at once apparent. In 1763, the resident population had increased to 8,000, and the floating, or home-going portion, to 5,000 more. Two years later (1765) the Labrador coast, from the entrance of Hudson's Strait to the River St. John, was attached to the Governorship of Newfoundland. During the wars which followed the French revolution, Newfoundland attained great prosperity, wages amounting to a high figure, and the "catch of fish" amounting to three-fold its former value. Yet as late as 1811, four years after the establishment of the first newspaper, only seventy years ago, no house could be erected on the island without the permission in writing of the governor. About this time, Governor Waldegrave wrote to the sheriff of St. John's:—"You will take good care that Jeremiah Morotty and John Fitzgerald do not erect chimneys to their houses, or even light fires in them." (A piece of parental despotism which sounds oddly enough in our day.) In 1814, the colony was increased by the arrival of 3,000 emigrants, the inhabitants then numbering 80,000 souls. In 1825, the first roads were constructed, and in 1832, representative government was established, and extended in 1855. In 1858, the first Atlantic cable was landed at Bay of Bull's Arm, Trinity Bay; eleven years later, the census showed the population had increased to 161,144; and at the present date, the estimated return places the number of inhabitants on the island and the adjacent Labrador coast at 190,000.

Physical Features.

Newfoundland is a large island situated in the North Atlantic ocean, between the parallels 46° 36′ 50″—51° 39′ N. lat., and between the meridians of 52° 37′, and 59° 24′ 50″ W. long. It forms an irregularly shaped triangle, about 2,000 miles round, and its coast—one of the most rugged and picturesque in the known world—is indented with numerous magnificent bays and harbours. Its greatest length, from Cape Ray to Cape Norman, is 316 miles; its greatest breadth, from Cape Spear, at the mouth of St. John's harbour, to Cape Auguille, 317 miles; and its area—42,000 square miles—is about that of England. It forms that outlying and detached part of the American continent which lies nearest to Europe, the distance between its most easterly point and the harbour of Valencia, in Ireland, being only 1,640 miles. Its greatest width is at its most southern base, extending from Cape Race to Cape Ray, and its narrowest point is at its northern extremity. It is almost severed into two portions by the great bays of Placentia and Trinity, the isthmus between them being but two miles wide, the southern, or larger division, forming the peninsular of Avalon. This, by reason of its extensive seaboard, and the excellence of its fisheries, is by far the most thickly settled, and commercially important, part of the island. So much for the concrete and external aspect of Newfoundland.

Of the interior of the island, little is yet known beyond the description given of it by Cormack, an adventurous traveller, who, accompanied by a single Mic-Mac Indian,* in 1822, crossed it between Trinity and St. George's Bays:—"A vast savannah country, on which countless herds of reindeer browsed, the ponds and rivers abounding with beavers, otters, musk-rats, wild geese, ducks, curlews," &c. Thirty years ago Professor Jukes described the interior of Newfoundland as reminding him of English landscapes. On ascending a hill from the spot on which he first landed, he tells us he saw "a tract of low undulating land covered with a rich sea of wood, stretching away into the interior for fifteen or twenty miles, backed by a range of blue hills in the horizon that rose towards the south-west, while towards the north-east they died away and coalesced with the hills at the head of the bay," and he winds up by declaring it to be "a most lovely, and almost English, picture." And, indeed, anyone who travels from the seaboard into the interior of Newfoundland will be surprised at the many reminders of English scenery he will meet with. It is, nevertheless, true that the interior of the island, more particularly towards the northern side, is as unknown and undeveloped a region as the heart of Africa. Geologically surveyed, and described by Alexander Murray and later travellers, it consists of a table land of undulating open steppe country, called "barrens," covered with moss, and a short, sedgy grass, abounding in morasses, and innumerable lakes and ponds, into and out of which flow streams of various sizes, the bottoms of the shallow valleys through which they run being covered with scrub, and occasionally with pine woods.

Perhaps the strongest recommendation this interior country has to present to public attention and favour is, that it offers no engineering difficulties to the construction of a railway, for which a preliminary survey was made by the eminent engineer, Mr. Sandford Fleming in 1867-68. Such a project has long been agitated, and is absolutely needed to develop its resources, and connect the severed portions of the island. A ridge of hills traverses the island almost parallel with the long range, along the slopes of which the line might run, thus avoiding the more swampy land. These hills nowhere rise to a greater height than one hundred feet. There are no ranges to tunnel, or large rivers to bridge, while wood for sleepers is abundant.

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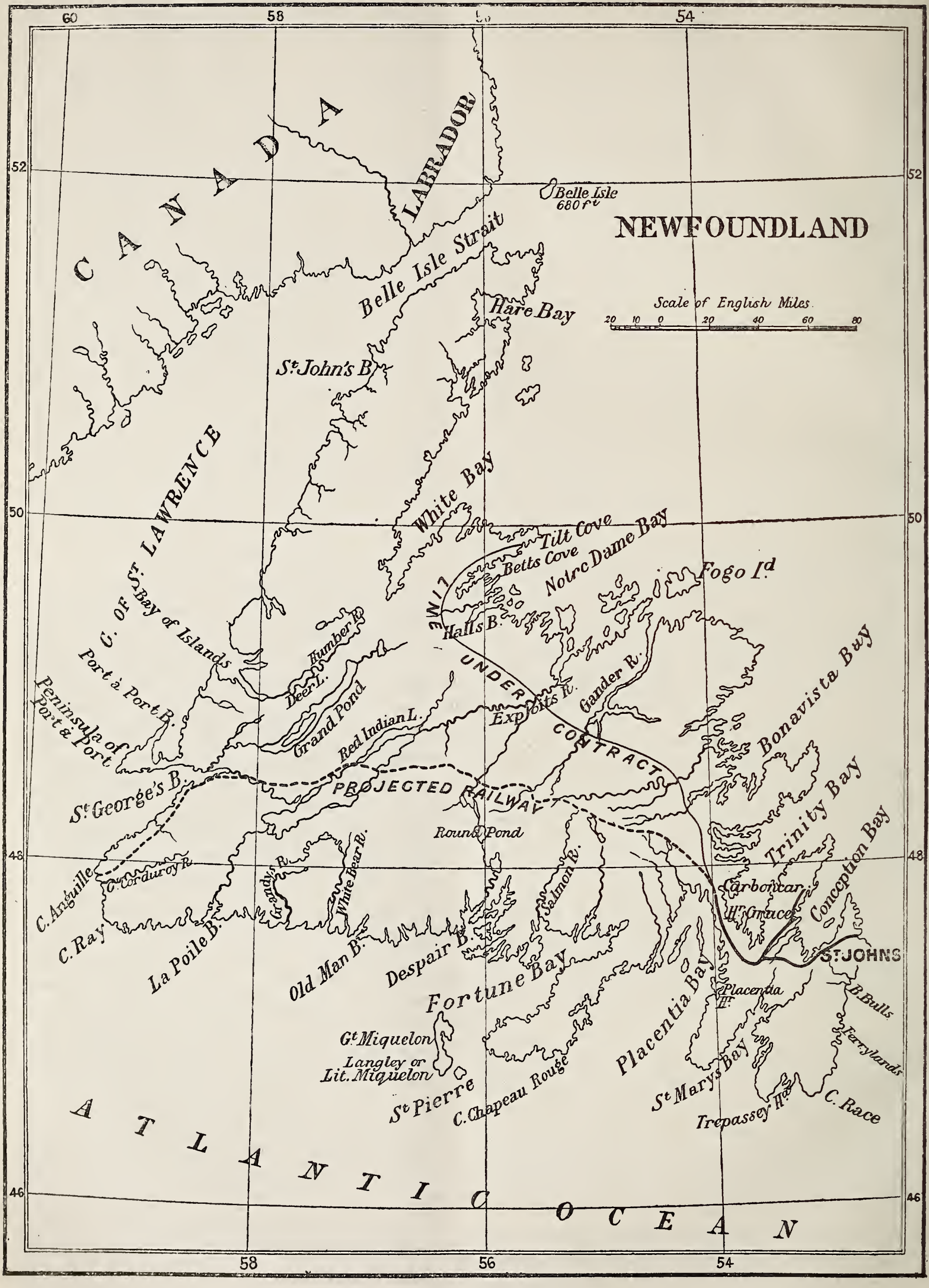
* These Mic-Macs—a remnant of the once famous Nova Scotia tribe, between 200 and 300 in number—are the only Indians now existing on the island.



MAP OF NEWFOUNDLAND.

The whole length of the proposed line—200 miles—is certainly not so great as to render its construction insurmountable. On the western side of the island, St. George's Bay offers a splendid harbour, with a climate much milder than on the east coast. By "the hand of nature," adds a recent graphic writer (Rev. Moses Harvey, of St. John's), "a great plain has been spread from east to west, thus marking, unmistakably, the proper route for a road across the island." The outer coast may be termed mountainous, though the summit of the ranges do not reach any great height. The highest land is found on the southern and eastern coasts, thence sloping towards the Great Northern and Eastern Bays. The interior is a vast elevated plateau, having ranges of minor hills at intervals. In many parts of the interior are to be seen isolated peaks, locally called "Tolts." Standing up in bold relief from the surrounding low country, they serve admirably as landmarks.

Reference to the accompanying map will show how lavishly nature has endowed the island as the great fishing ground of the world. Within a degree of the south coast, is situated the most extensive submarine island yet discovered—the Great Bank of Newfoundland, 600 miles long, and 200 broad. Around the edges of this island, are countless smaller submarine elevations; these form the breeding grounds of the cod, the staple product of the Newfoundland waters. These have been fished for centuries, without showing any apparent diminution in the supply. When to its sea treasures, which are literally inexhaustible, and are carried by means of its wonderfully indented coast line, and its varied water system, to the very doors of the people, we add its mineral wealth, its pine forests, and its plains yet untouched by plough or spade, the least thoughtful and observant among us must recognise what should long ago have been apparent—that human industry, skill, and enterprise are alone required to raise Newfoundland to a far higher position among Britain's fields of colonisation than she has yet occupied.

CLIMATE.

The Island of Newfoundland would possess many attractions for intending emigrants from Great Britain and Ireland, if people could once divest themselves of the traditional fallacy that this country is situated in the region of perpetual snow and frost. Newfoundlanders do not all live in wigwams and tents, nor do they dress after the fashion of Esquimaux and Laplanders. The climate, though undeniably a moist one, is nevertheless a most healthy one. The temperature during the year is remarkably equable. The mercury in winter seldom falls below zero of Fahrenheit's scale, or in summer rising above 90°, whilst the mean temperature for the year is about 44°. The mean daily range of temperature for 1880 was 11·15. Fogs, which have earned for the place so unenviable a reputation, are mainly confined to the south and south-eastern shores, the northern and western coasts, as well as the interior, being free from them. St. John's is pronounced by climatologists the wettest and most cloudy place in her Majesty's dominions, and much of the misconception which is entertained abroad with reference to the climate of Newfoundland is due to the fact that the meteorological system or weather chart of St. John's is too generally cited and accepted as a fair sample of the whole island. From this simple circumstance has sprung another of the popular errors which has prejudiced the English mind in regard to this colony. To judge of the climate of Newfoundland by the barometrical readings of the City of St. John's is not less absurd than it would be to judge of the climate of the British Isles at the Orkneys, or Land's End, or of that of the North-west Territory by the weather record of Victoria on Vancouver's Island.

The position of St. John's—occupying as it does the extreme eastern promontory of the Avalon Peninsula, only a little south of Cape St. Francis itself, intercepting, so to speak, the ice-laden Arctic current as it flows southward—is an exceptional one, and furnishes no fair standard by which to judge the weather influences in other parts of the island. "The immense body of ice," writes Mr. Howley in his excellent manual, "annually brought to our shores by this same Arctic current, chills the atmosphere along the whole coast; after drifting southward, it comes in contact with the tepid waters of the Gulf Stream, when it quickly melts, producing an enormous quantity of vapour, which is brought back to our shores during the summer months, in the shape of fog." The summers, though short, are very pleasant, the thermometer on the east coast rarely rising above 80°, and the fierce heats and frosts of Canada and the United States are equally unknown.* It has, not inaptly, been designated the "Norway of British America." The best climate is found on the west coast, on what is called the French shore. In that section the temperature takes a somewhat higher range in summer, and a correspondingly lower range in winter. At Sandy Point station, in St. George's Bay, for some years past the daily summer register has been between 91° and 95° in the shade.

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* The thermometer is 81° in the shade this morning, writes my friend, Rev. Moses Harvey, from St. John's, July 22nd, 1880, and by the afternoon will be two degrees higher.

I will now glance at the topographical features of the island, as these greatly influence the climate.

PENINSULAS.

Projecting from the main body of the island, and, in an imperfect sense, forming its south-eastern, western, and northern angles, are the three main peninsulas or promontories of Avalon, already mentioned; the northern peninsula, or *le Petit Nord*, of the French, and the peninsula of Port à Port, which is much the smallest of the three. Cape *Chapeau Rouge*, on the south coast, between Placentia and Fortune Bays, is also important.

BAYS AND HARBOURS.

St. John's, the capital, is situated on the east coast, about the centre of the Avalon peninsula. Its harbour, which is entered through what is called "The Narrows," is spacious and well sheltered, and so admirably guarded by nature, that it could be readily rendered an impregnable fortress. It is 90 feet deep in the centre, and is readily accessible at all seasons of the year, and at all stages of the tide. On either side of The Narrows, rise precipitous sandstone hills, to the height of 600 feet. That on the south side has near its base a lighthouse and battery called Fort Amherst.

St. John's occupies a commanding position on the north side of the harbour. Though founded in 1572, and therefore three hundred and ten years old, it betrays no marks of age. This is owing to the ravages of fire, by which it has been thrice swept. Its most important and conspicuous edifices are Parliament House, Government House, and the Roman Catholic and English cathedrals. With a resident population of nearly 30,000, the number of its inhabitants are doubled at certain seasons, notably on the arrival and departure of the fishing fleets. At such times the streets are filled with brawny stalwart men, roughly dressed, but respectable looking, who are taking the opportunity to "flaner" in this fashionable centre before retiring to the sealing grounds of Labrador or the cod-fishing on the banks. Everywhere signs and evidences of the popular pursuits show themselves; outfitting stores for sailors and fishermen are conspicuous. Most of the merchants combine a wholesale with a retail business. Their front windows are stocked with miscellaneous goods, while their back premises open on storehouses full of cod, and private wharves alongside of which their own steamers and ships are moored. We will now take a cruise round the island.

St. Mary's Bay, 35 miles long and 25 broad, has a fine cod fishery, and several salmon rivers discharge into it. It is the first of the great bays on the south coast, entered after passing Cape Race and St. Shots. The land here is excellent, the fine arm of "Salmonier" stretches far inland, presenting a most inviting field for settlers. Trepassey, a fine harbour immediately to the westward of Cape Race, at the south end of the Avalon Peninsular, is always open. Placentia Bay, the largest bay in the island, is next entered; it is ninety miles long and fifty-five wide, clusters of islands dot its surface, and its waters abound with cod, herring, and salmon. It is separated from Trinity Bay by a narrow neck of land. Fortune Bay to the west of Placentia, is seventy miles in length. Guarding its entrance, like twin sentinels of the deep, stand the picturesque islands of St. Pierre and Miquelon, the sole remaining possessions of France in the vast continent of North America. The former of these islands is now used by the French as an operating station and repair depôt for the transatlantic cable. Fortune Bay abounds in fine scenery, and is the centre of an extensive herring fishery. History has, within a very recent period, added to the other attractions of this bay one of a more general character. It was here that the international dispute, known as the "Fortune Bay affair," took place. On Sunday, January 6th, 1878, a "mob" (for so they were described in the Dominion papers) of Newfoundland fishermen attacked the crews of several American fishing smacks, and compelled them to desist from seining for herring. In the course of the row which ensued, the tackle of the strangers was injured, and some fish that had been surrounded by nets were allowed to escape. A bill for 103,000 dols. for damages, which at most amounted to 2,000, was the result. It is creditable to our national sense of justice, as well as consoling to our pride, that this preposterous bill was not paid, but only £15,000 in lieu of it; and that what.

ever other interest Fortune Bay may possess, either for Newfoundlanders or ourselves, this is not likely to be enhanced by either interest or principal which was not fairly earned—or, in more fitting phrase, by a claim which had no principle in it.

Between Fortune Bay and Cape Ray is a straight line of coast known as the western shore; and beyond that, stretching 400 miles from Cape Ray to Cape St. John, the northern point of Notre Dame Bay, is the French shore. This is said by many to comprise the best portion of Newfoundland for agricultural purposes. Nearly 10,000 people have settled in this region, and it is capable of yet greatly increased settlement.

The pretensions of the French to exclusive sovereignty on this shore have culminated in a series of disputes, which, while they may possibly lead to complications, must open the eyes of the Imperial authorities to the necessity of maintaining British rights here. A brief narrative of the latest acts of the French within the past few weeks will add interest to the paper, as showing the troubles our people have had in consequence of the high-handed acts of the French authorities. Quite recently, at St. Antoine, on the north side of White Bay, some five or six Newfoundland schooners were engaged in cod fishing, and in no manner interfering with the operations of the French fishermen, when they were peremptorily ordered to weigh anchor and get out to sea by an official who went through the form of reading a document quite unintelligible to the poor fishers. They accordingly, not understanding their rights, or unwilling to practically assert them at the risk of violence, obeyed the injunction. One of these vessels, the *Glide*, commanded by Joseph Joy, had one hundred quintals of fish on board, and two boat-loads alongside, but the captain was not allowed time to take his fish on board, and was driven forcibly out to sea. The *Glide* set sail for Labrador, and, during a dense fog and heavy sea, ran on Mannock's Island, and became a total wreck, the crew barely escaping with their lives. Some time previously the schooner *Fanny* (Captain Barker) was driven out of Hillard's Harbour, being actually forced to tow out to sea, as it was quite calm at the time. On July 10, the *Lily Dale* received a peremptory "bag-and-baggage" order, and her captain, John White, of Twillingate, was constrained to leave his fishing-ground and proceed over 400 miles down the Labrador coast in order to get a full fare of fish. Several of our fishing craft, and notably the *Faun*, received similar treatment at Croque. The masters of the French vessels actually came on board the Newfoundland fishing schooners, went through the formality of reading some document in French, and then, with peremptory gestures, gave the usual notice to quit. More recent accounts state that a hand-to-hand fight took place between an officer of the French frigate *Chlorinde* and a fisherman named Guy. That about 12,000 British subjects are at this moment living, nominally, in a British colony and under the British flag, but on territory which, being neither British nor French, cannot be protected nor legislated for by either power, is a remarkable fact which urgently requires the consideration of the authorities.

For convenience of further description, Newfoundland may be divided into four divisions, which, similarly with the electoral districts—hereinafter described—are named after the principal bays within each division. Two western divisions, viz., St. George's Bay and Port à Port, Bay of Islands and Bonne Bay. Two north-eastern divisions, viz., Hare Bay and Pistolet Bay, and White Bay and Canada Bay.

Nôtre Dame Bay extends from Cape St. John northward, 40 miles in breadth, 250 in length. On the north and west shores of this bay are the now celebrated copper-mines of Tilt Cove, Betts Cove, Little Bay and Seal Bay. Green's Bay and Hall's Bay are arms of Nôtre Dame, each running 20 miles inland. All round these arms are fine tracts of agricultural and timber lands, while the fisheries are most productive.

Notwithstanding the iron-bound character of the coast, there is much picturesque scenery to be met with in a voyage round the island, which, no visitor to Newfoundland, if he has the time at his command, should fail to take. Twenty-five to thirty hours steaming by sea, from St. John's, will transport the traveller to the centre of the mining region—a distance of nearly 200 miles. The aspect which the coast presents for the greater part of the voyage is thus described by Mr. Harvey:—

> "The eastern shores of Newfoundland present no soft pictures of verdant loveliness—no pebbly beaches on which the waves break gently—no upland slopes clad in forest emerald. All is the massive grandeur of dark, perpendicular cliffs, at times sculptured into shapes of stern beauty or awe-inspiring forms; in other places, jagged and torn by the gnawing tooth of time,

and of rude and forbidding aspect. Such is the precipitous sea-wall, built, as it were, to repel the wild billows of one of the stormiest seas in the world. But the voyager has only to leave the coast and sail up one of those magnificent bays which stretch their great arms far inland, and he will find scenes of the rarest and softest beauty along their wooded shores and in their island-studded bosoms. As we steamed northward, we had glimpses of Conception, Trinity, and Bonavista Bays as we crossed the entrance of each; but as the *Hercules* was bound for Betts Cove direct we made no calls by the way. The main objects of interest along the shore are the lofty capes which project their extremities seaward from the line of coast and mark the entrances of the bays. I may remark in passing, that this lofty iron-bound coast is very well lighted, and can be approached with perfect safety at night, under the guidance of the friendly lighthouses erected at the points where navigation is difficult and dangerous."

Bonavista, Trinity, and Conception Bays complete the list of important bays on the east coast. These are from 50 to 70 miles each in length, and contain many fine harbours. The harbour of Trinity Bay, in particular, is reckoned one of the finest in the world. Conjunctively, these form nine magnificent estuaries, varying in length from 40 to 100 miles, and from 60 miles in width. St. George's Bay, Port à Port, and Bay of Islands, as we have just shown, are on the west coast. The coast of the entire island is almost everywhere what is termed iron-bound, rising frequently in bold precipices almost vertically from the sea.

Rivers.—The rivers of Newfoundland are, for the most part, narrow and winding, and unfitted for steam navigation. The three largest are the Exploits, the Humber, and the Gander. The Exploits—so named after the bay into which it flows—is the most important. It takes its rise in the south-western angle of the island, flows in a north-easterly direction for 200 miles, and drains an area of 3,000 square miles. The Humber has its source in the gorges of the Long Range Mountains, and after a course of 114 miles empties its waters into the Humber-arm, Bay of Islands. The Gander, in two branches, drains an area of 2,500 square miles, and flows into Nôtre Dame Bay. Indian Brook, falling into Hall's Bay; the Gambo and Terra-Nova, into Bonavista Bay; Rocky River, and Great Rattling Brook, are the names given to other and smaller streams. Indian Brook, with Indian Pond, forms the connecting link between Hall's Bay and the waters of the Humber on the west coast. During good states of water it is navigable throughout its entire length of forty miles. Rapids—called by the natives "rattles"—and chutes are numerous, and the navigation in shallow water difficult.

Lakes, Ponds, &c.—Newfoundland is certainly entitled to be considered a lacustrine region. It is estimated that a third of the surface of the island is covered by lakes and smaller sheets of water. From the tops of the highest hills more than one hundred lakes and ponds have been counted at one time. Of these, Grand Lake, or "Pond," on the Humber, 192 square miles in extent, and 56 miles long, is the largest. Red Indian Lake, 36 miles in length, Gander Lake, and Deer Lake, are next in size and importance. Birchy Lakes, to the east of the Humber, afford some charming scenery. Many of these sheets of water, such as Esquadde gawe Gospen (Lost Pond), Ahwade angeech Gospen (Portage Pond), Elnuchi beesh Gospen (Sit-down Pond), Wachta peesh Gospen (Crooked Pond), and a few others, still preserve their Mic-mac names. Victoria Lake, which flows into Red Indian Lake, and Lake George IV., on the Exploits River, are respectively, 1,160 and 1,237 feet above the sea.

Islands.—Nearly two hundred islands, and groups of islands, have thus far been named. They are mostly situate on the east and south coasts. Perhaps the best known are Belle Isle, at the entrance to the Straits of that name, and St. Pierre and Miquelon on the south-coast.

Mountains.—All the great physical features of the island run N.N.E. and S.S.W. The largest chain of hills is the Long Range which, rising near Cape Ray, extends nearly the whole length of the western slope of the island, and terminates in the great northern peninsula. Outside, and parallel with the Long Range, stretch Cape Anguelle range, and the Blo-midons, their greatest altitude being 2,000 feet.* Nearly parallel with the Long Range, and crossing the island diagonally, towards Grand Lake and Hall's Bay, run the rugged range of hills to which no name has been yet given, but which would admirably serve the purpose of the now projected line of railway. There is also a middle ridge stretching between Fortune and Nôtre Dame Bays.

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* A high ridge near the head of La Poile river, La Poile bay, is said to be 2,064 feet above the sea. Second in point of elevation, to this, are peaks of the Blo-mi-don and Amicop Quotch ranges on the Humber and Exploits river.

Agriculture.—Until the commencement of the present century, Newfoundland had little to recommend it as a field of enterprise to the British farmer. A country in which for more than a century any cultivation of the soil whatever was held to be a penal offence; a country in which the enclosure of a plot of ground, the erection of a dwelling, or the most primitive form of settlement, has been permitted only within the last seventy years, can hardly be expected to show much progress in agriculture. The direction of capital and industry—as already stated—has been oceanward, not landward; to the seas—not to the soil; yet much of the country is capable of successful cultivation. The survey of the island, which has been going on vigorously since 1864, under Mr. Murray and his colleagues, has dispelled many of the fancies and fallacies which have, to the great prejudice of the public interest, hitherto prevailed regarding its topography, climatology and resources. Already a bright future begins to dawn upon a land so long shrouded in fog and fiction. Soil and climate are both best on the west coast, and there, consequently, are to be found the best openings for farmers. The following information is derived mainly from recent official reports:

Western Coast.—The St. George's Bay district, including the Codroy Valleys and Port à Port, contains 730 square miles of land, described as "more or less suitable for settlement," the most favoured being the coal-measure districts, where the surface is often flat or gently undulating over great areas.* Added to this the Bay of Islands, including the Humber Valley, the Deer Lake and Grand Lake country, contains 600 square miles, so that in this district (St. George's) there is a total of 1,330, square miles, or nearly one million acres of fairly good farming land. The valley of the Humber is well wooded and embraces a large area of country which appears to be provided with all the necessary material for ship building in a remarkable degree.

Eastern Coast.—On this coast the best farming lands are to be found on the arms and inlets of Nôtre Dame Bay, or the Gander River and Lake, and their tributaries, and in the Gambo and Terra Nova Valleys. There is room for a very considerable number of farms on the unoccupied lands around Hall's Bay, the produce of which would find a ready sale at high prices among the mining population. Unoccupied land can be bought for fifty cents (2s.) per acre. The extent available, in these localities, for settlement is officially estimated at 1,700 square miles. The Exploits Valley and Red Indian Lake region, which together embrace 1,620 square miles, have some excellent tracts, while Trinity, Bonavista, and St. Mary's Bays, more particularly the Salmonier arm of the latter, embrace some fine land as yet unsurveyed. In all the districts above enumerated the amount of land fit and open for agricultural purposes on, or, rather, a few miles back from, these two coasts, may, therefore, be roundly though roughly estimated at 4,500 square miles, or about 2,880,000 acres.*

"A large proportion," the report states, is heavily timbered and but little of it occupied." Of the Gander country, Mr. Howley elsewhere writes, "the soil here, over a vast arrea, is of excellent quality and capable of yielding rich harvests."...."Taking everything into account, I do not think a more promising country, or one more easy of access could be found in British America." It should always be distinctly borne in mind that these lands are heavily timbered, and therefore require clearing before farming operations can be commenced.

Land Laws.—Under the revised land laws poor settlers can obtain a *free grant* of 50 acres, and fifty dollars in cash on his clearing six acres. Unoccupied lands can be purchased at 30 cents per acre, in lots of 300 acres; and larger lots, varying from 500 to 1,000 acres, are obtainable on easy conditions of purchase.

Stock Raising, Sheep Farming, &c.

The resources of this island as a grazing country are far larger than has hitherto been suspected, and the recent surveys carried on in connection with the projected railway have disclosed the existence of large areas of rich grass land, well watered, and in every way adapted for wool growing. The climate is even better suited for the development of a heavy fleece than the warmer climate of most parts of Australia and New Zealand.

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* "The soil in many parts of this region," states Mr. Howley, "is extremely rich in quality, and, I believe, would compare favourably with any in British North America."

* The extent of land now under cultivation does not exceed 36,000 acres, 1-80th of the whole cultivatible area, and the annual value of all agricultural products is less than 750,000 dols. The most certain and prolific crop produced thus far is potatoes. Of these between 700,000 and 800,000 bushels are grown annually, equal to about four bushels to every man, woman, and child on the island. Under the stimulating influence of a liberal land policy, increased settlement proximity to the British markets, and the means of transportation between the capital and the mining region, which a railway right across the island will afford, it is not too much to expect that much of this land will in a short time be turned to account.

Two years ago an Act was passed to encourage sheep raising. The salient points of the Act are these:—The Newfoundland Government issues licenses for large tracts of lands to parties who will establish sheepwalks, and everything connected with their business is allowed to enter duty free. Any person who has kept 500 sheep on the land granted to him will, at the expiration of ten years, own the said land in fee simple for ever; and further, any two persons who will raise 500 sheep on such a piece of land will be given as a bounty the sum of 200 dols. each.

The grass lands and the rich belts running along the river banks are particularly well adapted to cattle raising. The land in the interior slopes up from the lakes and rivers like a series of steppes, one tier rising above another, and therefore easily and naturally drained. A few drains running parallel to the lake or river, with one main drain at right angles to these, would convert these almost boundless plains into rich pasture lands.

In Newfoundland the farmer would live close to the port of shipment, and the sea voyage is scarcely more than half the distance from New York to Liverpool, or, in other words, about five days' and a few hours' sail of English ports. For years to come, however, writes a competent authority, farmers in Newfoundland will have enough to do to supply the local market, for at present we have to depend to a great extent on Nova Scotia to supply our markets.

The cattle raised in the Western States have to pay for the heavy expenses attendant on long railway journeys of some thousands of miles, and then the sea voyage of three thousand miles, and it can readily be believed that after so much travel the stock cannot be in first-class order for the market. Yet this business yields a handsome profit to those engaged. If these men can make it pay, how much easier would it be to make it pay in Newfoundland? The export of cattle will yet be among the most remunerative industries of the island. At the same time, the proximity of Newfoundland to England affords special facilities possessed by no other colony, and by no foreign country, for the transport of meat, either alive or freshly killed, to the old country.

MINES AND MINERALS.

Next to her fisheries, the mineral deposits constitute the greatest present source of Newfoundland's wealth and prosperity. Not until a very recent period was it even suspected that the grim looking rocks of this "iron-bound" island contained mineral treasures of such enormous value that, when fully developed, they would go far to constitute it one of the world's great mining centres. Mining enterprises, first undertaken in 1863, have been greatly extended. Since 1870, copper mines have been rapidly opened on the north side of Nôtre Dame Bay, and the present export of this ore now averages 45,000 tons annually. Professor Stewart, geologist, in the Mining School of Nevada, at Virginia City, in a recent paper, described the copper ore of this region as a beautiful yellow sulphuret, free from arsenic or any undesirable ingredient, with a little iron; and containing from eight to twelve per cent. of pure copper. He had never seen finer copper ore in the course of his experience. The character of the rocks in which it occurred was such as to *give an absolute assurance of perpetuity in the working*. These rocks were metamorphosed and laminated; and the extent of mineral indications over extensive areas was such as rendered exhaustion, in the working, a practical impossibility. A more promising mining field for copper he had never seen anywhere. No fear whatever need be entertained that these mines would become exhausted. Judging by the laws which govern mineral deposits, the depth of the veins is such as to render them practically inexhaustible. He had traversed a region between Little Bay and Hall's Bay, where he had seen so much copper that his party were fairly surfeited, and agreed among themselves for a time to abstain from mentioning the name "copper," to such an extent had they been disgusted with the profusion. Before coming here (St. John's, Newfoundland), he had merely heard that there were some copper mines in existence—for, in America, Newfoundland was a *terra incognita*, or only known as a bare rock used for curing fish; but when he came, he felt "astounded at what had been done in copper mining in the short space of five years, mainly by the energy and enterprise of one man, whose modesty prevented him from mentioning his name." He referred, of course, to Mr. Ellershausen. He found that already Newfoundland stood sixth in the roll of the copper-producing countries of the world, and that during the last five years copper ore had been extracted to the value of four millions of dollars, and about one million dollars had been expended on "mining plant" alone. He expressed his admiration of the arrangements for conducting mining operations at Little Bay—a mine now yielding 2,000 tons of ore monthly. Looking to the future, he had every reason to believe that Newfoundland was destined to become one of the greatest copper-mining countries in the world; and he believed that this industry alone would yet raise it to a very high place. The first mine (the "Union," at Tilt Cove) was opened by Messrs. Bennett and McKay, in 1864. Bet's Cove mine, 12 miles south of Tilt Cove, was opened by Mr. Ellershausen, of Nova Scotia,* in 1874. In four years it yielded 102,400 tons of copper, valued at £512,000, being at the rate of 26,000 tons of ore annually. Not a bad return for a Terra Novian copper mine. But Little Bay, opened August, 1878, promises to surpass both these in productiveness. At Copper-cliff mine, on the 21st September, 1878, no less than 520 miners were engaged in quarrying ore. A tramway, nearly a mile in length, connected the mine with the harbour. Houses, stores, and a wharf were built; 3,000 tons of ore had been shipped, and 6,000 tons of rock removed in six weeks.† More recently mining operations have been commenced in Robert's Arm and Seal Bay, but with what results is not known. Between the mining region on the east coast and the navigable waters of the Bay of Islands on the west, a railroad 100 miles in length will ultimately be laid down.

Gold.—Nor is Newfoundland less likely than her neighbours, Nova Scotia and Quebec, to share in the wealth acquired in the search for, and utilisation of the more precious metals.

The formation, in which the ore occurs, is serpentine, belonging to what is termed, in Canadian geology, the "Quebec group" of the lower Silurian basis, the great metalliferous formation of North America. Where no serpentine exists it is vain to look for ore. The ore in Newfoundland occurs in beds or pockets—not in veins—and, in the localities already opened, is extracted with great facility. Mr. Howley estimates the total area of the serpentine or ore-bearing formation at 5,000 square miles. Mr. Murray says:—"I feel bound to state that the experience of the late investigation convinces me more than ever that many of the northern parts of this island, and the great bay of Nôtre Dame in particular, are destined to develop into great mining centres, should capital and skilled labour be brought to bear in that direction."* The north shore of Conception Bay, two miles from Brigus, and in the immediate neighbourhood of Brigus Lookout, has been the principal scene of Mr. Murray's investigations. Here, after a careful examination, he selected a ledge of quartz which seemed the most promising. A hole was drilled underneath it, and the first blast detached from two or three cubic feet of quartz, with chlorite patches. In this mass, within an area of a single cubic foot, no less than ten "sights" of gold, as the miners call them, were obtained— that is, small masses of the precious metal, some of them mere specks, barely visible to the naked eye, others containing each about eight or ten grains of gold. The fragments of quartz were put into a bag, and on shaking it out afterwards, a small piece of gold weighing four grains, was found, which had been detached by friction in carrying it to Brigus. The quartz veins, in one of which the gold was found, are reticulated over a considerable area, and intersect a green felsite magnesian slate of the Huronian age. They vary from one inch to a foot in breadth. The veins frequently intersect one another, and at the points of intersection form a knot or boss. It was in one of these knots that the gold was found. The quartz holding the gold particles is associated with a dark green chlorite, and in the chlorite patches the gold is seen finely distributed. The reticulated veins of quartz are chiefly limited to an area of country nearly a mile in breadth, and three miles in length, extending from Brigus Lookout in a south-west direction. Various reports are in circulation to the effect that gold has been found at a much greater distance inland, in the same direction. Mr. Murray also visited Fox Hill, about two miles from the former locality, and obtained a gold specimen which had been found there by a resident. From an examination of the district, and the evidence furnished, he is strongly of opinion that there is here an area of country six miles in length, and a mile in breadth, which, if judiciously explored and properly worked, will be found auriferous. As yet he has not been able to get the quartz specimens which he has brought with him analysed, so as to ascertain what amount of gold is distributed throughout the mass, invisible to the eye. Mr. Murray further says :—"That a large area of country in the region referred to is auriferous, there can scarcely be a doubt, although nothing short of actual mining and practical experience can possibly prove what the value of the produce may be; or whether the prospects of obtaining a remunerative return for the necessary outlay are favourable or otherwise. The specimens which have been obtained, although an unquestionable evidence of the presence of the precious metal, cannot by any means be taken as indicative of a certain average yield." Further on he remarks :—"The indications of gold in this country, then, are certainly sufficiently favourable to merit a fair trial; and there are good reasons to hope and expect that ample capital applied to skilled and judicious labour may be found remunerative to future adventurers, while a new industry will be added to give employment to the labouring population of the island, and possibly bring this despised and but little known colony into more prominence and consideration abroad than it hitherto has enjoyed."

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* The mining properties and interests of this gentleman are now controlled by the Newfoundland Consolidated Mining Company, with a capital of three million dollars, and a head office in New York.

† All these localities, more particularly Hall's Bay, have picturesque scenery, and the visitor to St. John's will be well repaid for a voyage up the coast, and an inspection of the miners and their surroundings.

* Geological Report for 1875.

Deposits of lead have been found at La Manche, Placentia Bay, and at Port à Port on the French shore, but they are at present unworked.

Coal exists in the St. George's Bay district, on the Humber River, and in the neighbourhood of Grand Lake from Humber River along the banks of Main Brook to Sandy Lake, but thus far no mines have been opened. Iron ores exist on every side of the island, and in all the bays. Magnetic iron ore has been found at Cairn Mountain in St. George's Bay; and gypsum, marble, building stones, and roofing slate in great abundance and of fair quality in various parts of the island.

Geology.—The following column represents the geological formations of Newfoundland as they succeed each other in descending order:—

Carboniferous :—
- Coal measures.
- Millstone grit.
- Carboniferous limestone.
- Gypsum conglomerate.

Devonian :—
- Gaspé sandstones.

Middle Silurian :—
- Clinton.
- Medina.

Lower Silurian :—
- (Trenton Group)—
  - Hudson river.
  - Utica.
  - Trenton.
  - Birdseye.
- (Quebec Group)—
  - Serpentine and Metalliferous.
  - Sillery sandstone.
  - Levis.
  - Calciferous.
  - Potsdam.
  - Primordial.

Huronian :—
- Huronian.

Laurentian :—
- Upper and Lower Laurentian.

Timber.—All the extensive tracts of good land are more or less densely timbered. The most valuable timber grown in Newfoundland is the white variety of pine (*Pinus strobus*). It is especially prized for the manufacture of lumber. In the Gander country alone, Mr. Howley estimates there are 850 square miles covered with this growth easily accessible by means of small boats on the Gander river. The yellow or red pine (*Pinus resinosa*) is another well-known variety. Neither beech, elm, oak or cedar are found. Around St. George's Bay, and in the valley of the Humber also, are fine forests of timber. The colony derives no revenue from its forests, which are cut at will by all comers.

We now come to the staple interest and leading industry of Newfoundland, the fisheries

FISHERIES.

Of Newfoundland it may truly be said, "*Super pisces respublica condita est.*" Upon fish rests the permanence and prosperity of the whole colony. In the excellence of the fish, not less than in the extent of the "catch" or yield, Newfoundland ranks *facile princeps* among the countries of the world. The following table shows the progress in value of the Newfoundland fisheries, during each group of five years, from 1852 to 1876, inclusive :—

Average value of Exports—group of five years—

	Dollars.
1852 to 1856	5,166,129
1857 to 1862	6,132,392
1862 to 1866	6,080,445
1867 to 1871	7,011,407
1872 to 1876	7,847,661

The value of the exports for the past five years will, it is stated, in Professor Hind's "Report on the Effect of the Treaty of Washington on the Newfoundland Fisheries," show an advance upon these figures, though perhaps not a large one. Although ranking as the largest fish-producing and exporting country in the world, we, pathetically writes a Newfoundlander, never sent so much as the tail of cod to the late fish exhibition at Berlin. The principal fisheries are those of cod, seals, herring, and salmon.

Cod Fishery.—Of cod fisheries (*Gadidæ*) there are several varieties, cod, haddock, and ling being the most common and most abundant. The Newfoundland cod fishery covers an immense area. It is not confined to the shores of the island, but is extensively pursued on the neighbouring banks and along the Labrador coast. For nearly four centuries these waters have been fished, and yet the cod grounds show no signs of exhaustion. The annual "catch" is estimated at 2,750,000 quintals of 112 lbs. each, and valued at £1,180,302. The average annual export for five years (1871-75) has been 1,333,009 quintals, while that of the whole Dominion of Canada for the same period was only 785,425, and that of Norway 751,382 quintals. The total value of the "catch" for 1878, including the oil, was 4,314,396 dols. The value of codfish has advanced from 50 to 75 per cent. during the last 12 years.

The Bank fishery still continues to be mainly carried on by the French and Americans. This year (1881) it is reported to be unusually productive. About one-fourth of the whole "catch" is taken on the Labrador coast. The total value of the fishery amounts to about £800,000, while upwards of 4,000 tuns of cod-oil and cod-liver oil are annually exported. The season follows closely upon the seal fishery season, and extends from the end of May till early in October. Scarcely, indeed, is the seal-fishing at an end when the cod-fishing begins. The crews which have returned from the Arctic hunting-grounds, transfer themselves into the small brigs and schooners used for fishing on the banks, while others return to the coves and creeks to which they belong, and fish from the shore. In June, the fleet leaves St. John's, and remains away three or four months, as the case may be. Cod-fishing does not possess any of the excitements of seal-hunting. It must, on the contrary, be a most dreary and tedious occupation. Before daylight, the crews leave the vessels in small boats, and lay down the long lines to which "snoods" baited with herring are attached, returning in the afternoon to haul them in. The fish are cleaned on board, and the insides thrown overboard, so that it has been suggested that the enormous quantity of fish's entrails annually thrown into the sea at the banks might damage the fishing, but it does not seem to have had this effect. The men fish on what is called the "credit system," the owner of the vessel furnishing them with the materials for fishing, and sharing the profits with them. To the attractions of the coast this fishery lends an especial charm, for it contributes its most picturesque feature to the scenery. The bays and coves within easy drives of St. John's are all worth a visit, if it be only to see the way in which the "cod-flakes," as they are called, and stages, are perched about the rocks. The roads are numerous and excellent, though they are for the most part very short, which lead in all directions from the capital. The country is a wild, open, undulating expanse, rising in rounded hills to an elevation in its highest parts of 600 or 700 feet. And all round St. John's, abundantly dotted with small farms, innumerable clear trout streams unite the lakelets that lie embosomed here and there in the woods of rather dwarfed spruce and fir trees; while marshy spots of peat and coarse grass afford a home to abundant snipe; and plains covered with stunted juniper, tamarisk, and berry-bearing shrubs, complete the landscape. It is across this country that one drives to Portugal Cove—a large fishing village nine miles from St. John's—where one may take steamer and cross Conception Bay to Harbour Grace, the *Havre de Grace* of the French nomenclature. The road crosses a table-land upwards of 500 feet above the sea-level, on the summit of which a lake called Twenty-mile Pond is surrounded by low hills, and several farms are dotted along its shores; but, as a general rule, these are only accessory to fishing, the land being rarely sufficiently productive to afford a return unaided by any other industry.

The village of Portugal Cove which is passed on the way consists of a cluster of 200 or 300 cabins, perched in the seemingly inaccessible niches amongst the rocks on the side of the deep cliffs. Generally the ground is too uneven to afford foundations, and these are supplied by posts, which are fixed into the rocks so as to support the sills. Each cottage has its own rough approach, sometimes over crags, sometimes up wooden ladders, or stairs rudely cut out of the rock, so that the process of circulating from one house to the other is a matter of considerable difficulty. Add to these quaintly-constructed habitations, beetling cliffs, rocks projecting into the sea covered with fishing-stages, a brawling stream and waterfall; clumps of pine trees, which have escaped the fire, nestling among the rocks; a magnificent sheet of water twenty miles across, glittering golden in the setting sun, surrounded with high land that ends in rugged promontories and deep bays, except to the northward, where the Atlantic forms the water horizon—and you have Portugal Cove. To the front is the Bell island, remarkable from the fact of being a good farming locality, entirely free from the rocks and stones of the mainland, and with an altogether different soil. It is thickly populated—Conception Bay itself, across which we are now looking, supports on its shores a population of about 40,000 souls. At the towns of Harbour Grace and Carbonear, only three miles apart, the population amounts to about 12,000; but one need not go further than Middle Cove, Logie Bay, or Quidi Vidi, to have samples of coast scenery and fishing villages, which are repeated in endless variety all round the island. Wherever the Atlantic waves rest or eddy for a moment in the clefts or crevices of the rocky precipitous cliffs which overhang the water, and wherever in the neighbourhood of such a smooth spot there is a shelf or ledge of rock favourable for the purpose, the settlement of the cod-fisher may be seen. Here he erects his "stage" and cod "flakes." The former, a rough shanty made of the boughs of pine-trees, and roofed with bark, is generally perched on stakes firmly wedged into the rocks. They are placed as near the water as possible, for in these little rooms the fish are received from the boats, and cleaned preparatory to being laid out on the flakes. They sometimes seem perched like gigantic nests over the waves, one advantage of proximity to which is, that all the refuse falls directly into them. Another requisite to a favourable location is a convenient approach to the flakes; these are erected on poles in the immediate vicinity. In Quidi Vidi there must be at least an acre of these singular-looking drying-grounds.

In the spring of the year the women and children are engaged in the woods cutting small pine-boughs and making them up into bundles, to be spread upon these erections; and then, as soon as they are split, and salted and soaked, the cod are spread out in the sun to dry, being caried from the stages in hand-barrows, up steps often ingeniously contrived on the face of the rocks. Under these flakes one may walk in some of the fishing stations for hundreds of yards, completely roofed in by cod-fish, which exclude the rays of the the sun from the alleys beneath, so as almost to remind one of the shaded streets of some Eastern town. As may be imagined, the smell does not induce one to linger long in these shady but fishy purlieus. Wherever there is building room, the rude shanties of the fishermen, who in many instances only use them during the summer, are put up—each containing a couple of bunks, roughly constructed, a backing of stones against which the fire is made, no chimney, much less windows. The smoke finds its way out through a hole in the roof, through which and the doorway the inmates receive light and air. A wooden bench, and a barrel-head on a single leg for a table, complete the furniture. Altogether if there is a great absence of comfort, combined with a powerfully odoriferous atmosphere, pervading the whole establishment, it is scarcely possible to imagine anything more picturesque — the upturned boats stowed away in convenient corners; the labyrinths of stages and flakes, perched like Malay villages over the water, or sticking against the rock wherever there is holding ground; the fishers' cottages glued to the rocks like birds' nests; the beetling cliffs overhanging all; and in spring the hugh blocks of blue transparent ice grinding themselves to pieces in these iron-bound bays on their way from the Arctic regions. Such is the picture of a Newfoundland fishing station as drawn by Laurence Oliphant in 1873.

In the early part of June the scene changes. At this time shoals of a small fish, called caplin *(Salmo Arcticus)*, swarm in the harbours, and in their attemps to escape from their enemies, the cod, are washed up in myriads upon the beach, where the women and children collect and scoop them up in bucketfulls. They are a delicate, tender little fish, not unlike sardines; not fleshy enough, it would seem, to make it possible to preserve them in oil; but they are salted and sent to Catholic countries as an article of diet; while they form, as long as they last, the best bait for cod. They appear in such quantities, however, that the country people take them by the cartload, and use them as manure for their land. One wonders why it is that the Newfoundlanders have neglected to turn to account as a source of revenue the quantity of fish-manure which their industry produces. The cod-offal which is now allowed to fall into the sea might be converted into fish-guano, and made a most profitable article of commerce. Indeed the French have had one of these factories at Quirpon, near the Straits of Belle Isle, which is said to furnish 8,000 to 10,000 tons of fish-manure annually.

Among the other marine products and wonders of the Newfoundland waters must be mentioned the now famous "Devil Fish." This monstrosity is said to attain its greatest size and ugliness off this coast, and a specimen exhibited to St. John's visitors fully attests the justice of the claim. Two specimens recently captured in Trinity Bay are described as having bodies measuring respectively 11 ft. and 20 ft. in length. They are furnished with tentacular arms which, when stretched to their full, formed the radius of a circle nearly 200 ft. in circumference. A smaller species of *cephalapod*, vulgarly known as the "squid," forms one of the productions of Newfoundland, on which, at certain seasons of the year, the fishermen principally rely for bait.

Seal Fishery.—Second only in importance to the cod fishery of Newfoundland, and first in the order of season, is the capture of seal. Scarcely is the seal-fishing over, when cod-fishing commences. Formerly seal-fishing was carried on by small but stoutly built sailing vessels of from 80 to 200 tons. Of this class of craft, in 1852, there were engaged 367 vessels, manned by 13,000 men, and of an aggregate capacity of 35,760 tons. Within the last ten years steamers have largely superseded sailing craft, and now almost wholly monoplise the trade. Twenty-five steamers—five of which formerly sailed from Dundee, and were engaged in the Greenland seal fishery—now sail from St. John's. The entire catch, however, has not very much increased since the introduction of steamers, ranging from 250,000 to 600,000 seals a season. These steamers are sometimes of considerable size, and cost from £8,000 to £10,000 a-piece. They carry as crew 200 and sometimes as many as 250 men each. It is with this class of steamers that the navigation of Hudson's Bay and Straits will, ere long, be carried on.

The fishing, or hunting season, commences, for sailing vessels, 1st March, and for steamers 10th March, and is usually continued to the middle or end of April. The largest number of seals ever brought into St. John's by a single steamer, was 40,000. Often, however, both steamers and sailing vessels return "clean," or with but a few seals. The following extract from a St. John's paper will serve to illustrate the varying fortunes of the seal hunter:—

> "On the 10th of March, in 1880, when the sealing fleet left St. John's, the ice was across the Narrows, and the steamers had to cut through it. They steamed northward, as has been their custom, to find that they had passed the seals. As one by one they have been coming in, they have only one tale to tell —of comparative failure. The *Walrus* accidentally struck the ice on her passage out of Greenspond, and filled up with seals, and then loaded a second trip in less than a month. She is off on her third trip. But here is the way they have come in:—*Captain White*, 5,600, instead of 30,000; the *Greenland*, owned in Montreal, 200, instead of 25,000 or 30,000; the *Falcon*, clean; *Captain Pike*, 2,000, instead of 30,000, &c.—through the whole list. But to make up for this, all along the shore seals have been taken by the people in thousands. It has never been known so before. It is computed that from Bonavista to Cape Race, 80,000 seals have been taken. The advantages are many to the people. In the steamers the men get one-third of the gross valuation of the seals. In the other case they get all. Then the money earned is taken out of the country; in the other case they get all. It is hardly possible to compute the suffering and poverty retrieved by this timely providential interposition."

In ordinary seasons the entire "take" varies from a quarter to half a million annually, ranging in value from three quarters of a million to one and a quarter millions of dollars.* Upwards of 10,000 men are engaged in the seal fisheries; and when the fleets are in port the streets of St. John swarm with the men engaged in it. The dangers of this branch of industry, add, no doubt, a zest to it. The first difficulty, when the seals have been spied from the masthead, is to bring the steamer in such a position as will enable the men to approach them, either by landing on the ice and jumping from pan to pan if the floe is not solid, or by punts, if they are not accessible in any other way. Each man is armed with with a "gaff," or club, with a hook in it, a "scalping-knife," and a "towing-line;" while a few of the older hands and best shots carry rifles. The work of destruction then goes on apace. The ice is covered with "white-coats,†" young seals not yet six weeks old—and their mothers, whose grey furs, in the case of "harps" or saddle-backs, are distinguished by a large black mark in the shape of a harp; "dog-hoods"—male seals, so called from a hood which they can inflate so as to protect their heads when attacked; "bedlamers," or one-year old males, on whom the harp has not yet appeared; "blue backs," or young "hoods," and other varieties, each with its special appellation. The havoc which a couple of hundred men, plying their clubs mercilessly in the midst of these helpless victims, work in a few hours may easily be imagined. A blow on the nose is followed by a cut down the centre of the seal from the throat to the tail with the scalping knife, which detaches the carcase from the "pelt." Technically speaking, the pelt consists of the skin and about three inches of fat with which it is lined, and to which protection of nature in the way of covering the seal owes his power of keeping himself warm in the peculiar temperature which he affects. The pelt is rapidly stripped from the quivering carcase, and laid flat upon the ice; and when five or six are thus collected, they are laced together in a bundle and drawn by the towing-line to the ship. To one not hardened to it, the whole process is said to be a most painful one to witness. The moans of the young seals, the agonies of the mothers at seeing them slaughtered, the fierce battles sometimes waged by the old "dog-hoods," who often make such sturdy resistance that they require two men striking them alternately with their gaffs to kill them—the whole ice strewed with the skinned carcases, still preserving their original shape, and almost quivering with life—presents a scene which nothing but the hope of large profits and quick returns could harden men to. Seal-hunters, however, have no bowels of compassion. The pelts, on an average, are worth about 10s. a-piece, and a third of the profits go to the crew, so that every man has a most special interest in the result.

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* Those desiring to know more about this important branch of industry, are referred to extracts from an interesting paper on Newfoundland, by Mr. Laurence Oliphant, reprinted from *Blackwood's Magazine*, for July, 1873.

† The mermaid of good Capt. Richard Whitbourne, 1662.

Seals are reported to have been found in Grand Lake, Sandy Lake, and in other of the fresh waters of the island. As to how they came there is a problem for the naturalist to solve.

Herring and Salmon.—Of the *Clupæidæ* or herring tribe, the herring alone visits the Newfoundland waters. The centres of the herring fishery are Fortune Bay, Bay of Islands, and the Labrador coast. The Labrador herring ranks among the first fish of its kind in the world. Several varieties of salmon *Salmonidæ)*, viz., salmon, trout, capilin, smelts, &c., are abundant on the shores during summer. Trout are found in almost all the fresh river-waters and lakes; while salmon resort to all the larger rivers during the spawning season. Pickled salmon, and preserved salmon and lobsters, are also shipped in considerable quantities. In 1878 no less than 1,554,096 lbs. of the latter were exported.

SHIP-BUILDING.

Ship and boat-building have made some progress in the colony, as we gather from the returns for 1879 and 1880, contrasted with those of 1857.

	1857.	1878.	1879.	1880.
No. of vessels built..	88	95	155	132
,, boats ,,	630	—	—	—

On the 31st December, 1879, there was on the register, 1,691 sailing vessels, and 27 steamers, with an aggregate tonnage of 82,564 tons.

We now come to the trade and finances of the island.

IMPORTS, EXPORTS, REVENUE, DEBT, &c.

The revenue is mainly derived from duties on imports. In 1866 it was 721,390 dols.; in 1879 it amounted to 972,402 dols.

The imports and exports of the colony, including Labrador, for the past fifty years, have ranged as follows:—

	Imports, Dols.	Exports. Dols.
1829	4,096,995	3,451,545
1859	6,620,680	6,785,565
1866	5,784,849	—
1876	7,205,907	6,591,701
1879	7,261,000	7,241,595

In 1880, the total imports and exports were £2,625,417. By far the largest share of the exports was sent to Great Britain, the total value of merchandise exported to this country being 2,067,636 dols., and to Brazil to the value of 1,383,819 dols. Portugal and Spain between them received goods to the value of 1,428,998 dols. The rest of the exports were sent in about equal proportions to Canada, the United States, the British West Indies, Italy, &c.

Flour, biscuit, molasses, sugar, wines and spirits, tea, and pork, figure among the principal imports. The exports are, of course, chiefly the produce of the fisheries, the principal items being:—Codfish, 3,490,482 dols.; herrings, 112,533 dols.; salmon, 110,070 dols.; lobsters, 116,880 dols.; cod-oil, 461,740 dols.; seal-oil, 598,368 dols.; seal-skins, 320,498 dols.; but copper ore and regulus figure for 555,790 dols. (29,617 tons having been sent to

England); ox-hides for 29,772 dols.; timber, &c., 17,000 dols. Besides the above returns of exports, the following articles were shipped during the year direct from Labrador (which is a dependency of Newfoundland), and are not accounted for in the Newfoundland Customs Report:—393,580 quintals of codfish, 16,962 barrels of herrings, 1,096 seal-skins, 196 tuns of seal and cod oil, and other fish produce, valued in the aggregate at 1,250,000 dols. Among the estimated items of expenditure are —*Relief of the poor*, 143,705 dols.; steam service, 136,800 dols.; telegraph extension, 7,000 dols.; education, 88,860 dols.; roads and bridges, 103,000 dols.; geological survey, 5,500 dols.; drawbacks to ship-builders, 17,000 dols.; drawback to bank fishery, 10,000 dols.; to encourage sheep raising, 1,000 dols.; and the public debt amounted to 1,457,290 dols. The profits derived from the Colonial Savings Bank are, by an act of the Legislature, devoted to the liquidation of the public debt, and that institution is reported to be in so prosperous a condition that the amount of the public debt held by the bank (595,849 dols.) will be liquidated in a period of sixteen years. Against the remainder there is now placed to the credit of the colony the balance of the fishery award (742,714 dols.), yielding 30,000 dols. per annum interest. Thus the whole of the public debt is virtually provided for, and the colony stands in the unique position of being, to all intents and purposes, free from debt. The population which, in 1857, was returned at 122,638, is now estimated at 190,000, including Labrador. Mr. Rogerson said, upon a general review of the position of the colony, it would be admitted that the affairs were in a thoroughly and most exceptionally healthy condition. Almost alone among Transatlantic colonies, Newfoundland can boast of having borrowed in its home market, and of having done so at the moderate interest of a fraction over 4 per cent.

GOVERNMENT.*

The Governor receives his appointment from the Imperial Government. He has a salary of 12,000 dols., paid by the colony, and a resides in Government-house, St. John's. The Legislature consists of two Houses of Parliament; the Legislative Council, or Upper House, formed of 15 members, chosen for life; and the House of Assembly, or Lower House, of 31 members, elected by the people every four years. The whole male population over 21 years, occupying dwelling-houses, either as owners or tenants, for one year, have the right to vote. The Executive Council consists of seven members—the Colonial Secretary, Attorney-General, Receiver-General, Solicitor-General, Surveyor-General, Financial Secretary, and Chairman of the Board of Works, constitute the chief Government officers, andare selected from the Lower House. There is a Supreme Court, with a Chief Justice and two Assistant Judges; also, two Judges of the Central District Court, Central Circuit Court, and Courts of Justices of the Peace, and a Court of Vice-Admiralty.

ELECTORAL DISTRICTS.

No county or township division yet exists in Newfoundland, the unsettled state of most of it, and the long-disputed claims of the French settlers, equally forbidding it. The electoral districts—ten in number—occupy nearly two-thirds of the coast-line, and are enumerated and classified in the table printed on the next page.

STEAM COMMUNICATION.

Steam communication is maintained fortnightly for nine months of the year by the "Allan" S.S. line, with Liverpool and Halifax, Nova Scotia. Two coasting mail and passenger steamers ply north and south from St. John's fortnightly, and at certain seasons a steamer runs to the west coast, and to Labrador, and a mail steamer plies daily on Conception Bay. The total amount of steam service subsidies expended annually by the Colonial Government, amounts to 136,800 dols.

RAILWAYS.

Notwithstanding all that has been said and written upon the subject, Newfoundland is yet without a completed railway. It is, however, a realisation of the near future. The Legislature, at its session, in 1880 (April 18th), passed an Act authorising the construction of a railway from St. John's, northward, to the mining region, with branches, and the Government were authorised to raise a loan of one million pounds sterling, on the credit of the colony, for its construction. Five years previously (1875), a survey was made from St. John's, on the east, across the island to St. George's Bay, on the west, having in view the establishment of St.

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* The Government of the Colony of Newfoundland consists of a Governor appointed by the Crown, an Executive Council of six, and a Legislative Council of eleven members. The present Governor-elect is the Hon. Sir Henry Berkeley Maxse, K.C.M.G., vice His Excellency Sir Jno. Hawley Glover, G.C.M.G., promoted to the governorship of Bermuda. Within the jurisdiction of the Governor of Newfoundland are the coast of Labrador on the mainland, and the Island of Anticosti.

Names of Districts.	Population, 1864.	Population, 1869.	Religious Denominations, &c.						
			Church of England.	Church of Rome.	Wesleyan Church.	Kirk of Scotland.	Free Kirk.	Congregational.	Baptist, &c.
Central.									
St. John's, East	17,811	17,204	3,985	11,200	1,838	157	286	344	1
St. John, West	12,763	11,646	2,532	8,746	1,088	153	128	97	..
Ferryland	6,419	5,991	173	6,246	..	..	..	..	..
Northern.									
Harbor Main (Conception Bay)	7,174	6,542	1,716	5,361	97	..	..	..	..
Port-de-Grave ,,	7,919	7,536	3,415	2,002	2,501	1	..	..	..
Harbour Grace ,,	13,055	12,740	7,239	4,013	1,615	9	179	..	..
Carbonear ,,	5,488	5,633	929	2,189	2,362	..	8	..	..
Bay-de-Verds ,,	7,434	7,057	439	1,775	5,220	..	..	..	..
Trinity Day	15,677	13,817	8,417	1,583	5,663	1	7	4	2
Bonavista Bay	13,008	11,560	6,860	2,599	3,531	..	12	2	4
Twillingate and Fogo	15,135	13,c67	6,989	1,956	6,172	8	2	7	1
Southern.									
Placentia and St. Mary's	9,857	8,794	1,351	8,254	239	11	2	..	..
Burin	7,678	6,731	1,648	2,689	3,351	..	5	..	..
Fortune Bay	5,788	5,233	4,391	1,387	8	1	..	..	1
Burgeo and La Poile	5,098	5,119	4,216	125	731	15	..	..	11
Electoral Districts	150,304	138,670	54,304	60,125	34,416	356	629	454	20
French Shore	8,654	5,387	3,768	3,716	991	85	68	7	19
Labrador	2,416	2,479	1,489	476	295	30	..	..	126
Total	161,374	146,536	59,561	64,317	35,702	471	697	461	165

John's as a port of call for steamers with passengers bound to Canada. Fast steamers were calculated to run from Galway, in Ireland, to St. John's in about five days, from which port passengers would then be able to take train across the island, and complete their journey by steamer across the Gulf of St. Lawrence to a Canadian port. It was estimated that a saving would be effected of from 30 to 48 hours for mails going by this route. Since 1875, however, other views have arisen, and now a line is under construction, for the purpose of developing the mineral and agricultural resources of the island, of about 350 miles in length, on the narrow guage (3ft. 6in.) system. The line at present under contract commences at St John's, and terminates at Hall's Bay, on the north shore of the island.

Along this line, there are on either side fertile belts of agricultural land, where comfortable homesteads may be established, and hundreds and tens of thousands of acres of soil turned into smiling farms. All along the line of the new railroad there is abundance of good sound timber, easily convertible into lumber for the building of dwelling-houses, barns, stables, &c., and as the line of railway passes close to the heads of the great bays of the Eastern ast, the facilities for procuring fish manure are very great. Abundance of sea-weed, or "kelp," is also procurable within easy distance of the contemplated farms. The raw material is all at hand, awaiting the muscle and energy of the tiller and husbandman.

A syndicate of New York capitalists, styling themselves "The Newfoundland Railway Company" have undertaken its construction within four years, and its operation, at an annual subsidy of 180,000 dols. for 35 years, and a land grant consisting of every alternative section along the line of road. Large tracts of rich, fine, and easily cultivated land on each side of the projected railway are in the hands of the contractors, who are now ready to dispose of them at extraordinarily low prices, and on easy terms, to intending immigrants. Independently of the main railway line and branches, there are, 2,457 miles of district and postal roads completed and in operation, and 1,200 miles in process of construction.

TELEGRAPH LINES.

The peculiar position which it occupies in the Atlantic with reference to the two hemispheres, has made Newfoundland one of the most important telegraphic centres in the world. Hitherto the island has been unable to derive any iadvantage from this source. When the original New York, Newfoundland, and London

Telegraph Company was created, the novelty of the enterprise dazzled the colony, as it did the world at large, and they accorded terms to the Company which could only be justified on the score of ignorance of the possible results. Not only did they grant the Company a hundred square miles of the mineral lands of the island, which are now turning out to be the most valuable, but they granted them an exclusive monopoly for fifty years, during which no other company was to have the right of landing cables on the shores of the island. The Newfoundland Government, fortunately inserted a clause by which this monopoly might be extinguished at the end of 20 years, upon the purchase by the island of the wires, apparatus, and general plant, at a valuation to fixed by arbitration. Since this arrangement was entered into, the original company has amalgamated with the Anglo-American and the French Cable Companies, and the term of the monopoly enjoyed by these companies has ceased. The cables of the Anglo-American Telegraph Company are landed at Heart's Content, Trinity Bay, thence messages are sent overland to Placentia Bay, and from thence extended by submarine cable to all parts of the mainland. Land lines are in operation from St. John's to Heart's Content, Placentia Channel, Bay of Islands, Tilt Cove, and Bett's Cove. Another company, known as *Le Compagnie Francaise de Télégraphie de Paris à New York*, a French company, whose cable was repaired by the contractors, Messrs. Siemens Brothers, in May, 1880, has a station at St. Pierre Island. This line embraces the following sections, viz. :—

	Miles.
Brest (France) to Penzance, Cornwall (branch)	150
Brest (France), St. Pierre, N.F. (main line)	2,200
St. Pierre to Louisburg, Cape Breton (branch)	200
St. Pierre to Cape Cod, Massachusetts, and thence through United States to New York	800
Total length	3,350

Among the items of colonial expenditure of the past year is one of 7,000 dols. for telegraph extension.

EDUCATION.

Education is wisely conducted on the denominational principle. The annual grant of 88,860 dols. is divided among the several religious denominations, in proportion to their numbers, and there exist local boards of education for each denomination, and one inspector each for Church of England, Roman Catholic and Wesleyan schools. There are four academies, connected respectively with the several denominations, in St. John's, and one grammar school in Harbour Grace. Some four years ago, the Roman Catholic bishop introduced the Brothers of the Christian Schools into the colony. The brothers opened schools under the auspices of the Benevolent Irish Society; but the old schools could not contain a tithe of the children who flocked for instruction. The society, aided by the public, determined to provide fitting accommodation, and soon a magnificent pile of buildings, known as the St. Patrick's Schools, was built, at a cost of over 50,000 dols., and fitted up with all modern appliances. Besides the schools, a fine residence for the teachers, known as "Mount St. Francis," has been built by public subscription. The general public interest in the erection of these educational establishments is a proof of the complete absence of all sectarian feeling in their midst. Although the Christian Brothers are an exclusively Catholic organisation, people of all ranks and religions, mindful only of the good results already achieved, and of the value of this teaching body to the youth of Newfoundland, came forward and generously supported the movement.

RELIGIONS.

In matters ecclesiastical, the population of Newfoundland enjoy the most unbounded freedom. The diocese is very evenly divided between the clergy belonging to the several denominations. The Church of England is represented by the Lord Bishop (Right Rev. Llwellyn Jones, D.D.), and seven Rural Deans; the Roman Catholic church by a Lord Bishop (Right Rev. Thos. Joseph Power, M.A.), a Bishop of Harbour Grace, a Vicar-General in each diocese, and an Administrator at each of the following places :—St. Peter's Chapel, St. Patrick's, Petty Harbour, Belle Isle, Topsail, Portugal Cove and Torbay, Witless Bay and Bay Bulls, Ferryland and Cape Broyle, Fermeuse and Reneuse, Trepassey, St. Mary's and Salmonier, Great Placentia, St. Kyran's, Burin, Oderin, St. Lawrence, Lamaline, Harbour Breton and St. Jacques, Caslemear, Brigus, Harbour Main, Conception Harbour, Northern Bay, Bonavista, King's Cove, Tilt Harbour, and Fortune Harbour. The Methodist, Presbyterian, and Congregational bodies are also well represented.

DISCUSSION.

The CHAIRMAN said they must have all listened with great interest to this paper, which gave much valuable information, and when disseminated through the columns of the *Journal*, would serve a most useful purpose.

Mr. RIDLEY (late member of the Legislative Council of Newfoundland), as a native of the island, congratulated Mr. Hall on the exhaustive manner in which he had treated the subject. He was afraid Newfoundland was very little known in England; it was the oldest colony, and the nearest, and yet it was the least known. If the people of England would interest themselves a little more in it, he was sure they would find it to their advantage, for they could invest their money much more safely and profitably there than in Capel-court. The climate, though not quite equal to that of England, was very good, and though they had fogs there, they were not like the London fogs, but white, arising from the contact of the cold water from the Poles and icebergs with the Gulf Stream. He was sorry to say, however, that, notwithstanding their fisheries, copper mines, and other advantages, they were still left out in the cold; though, happily, they could take care of themselves. They wanted practical men to come out, who would soon find what the trade capabilities of Newfoundland were; and he was sure if capitalists came with thousands, or even millions, and invested these in the colony, they would not regret it.

Mr. MORRIS said he did not come with the intention of speaking, but his firm having been connected with the island for some five or six years, he felt very much interested in the paper, which had been so complete, that there was hardly anything left for him to say. In 1880, his firm was called in to survey the first portion of the railway—100 miles in length —being a portion of the line going up north; and he had personal charge of the work. The original survey, by Mr. Fleming, was to go direct from the east to the west, with a view of forming a direct route to the Gulf of St. Lawrence. He could confirm all that had been said with regard to the capabilities of the island; it was undoubtedly very rich in copper and in nickel, producing a very large quantity every year, and it was only recently, he believed, that some of the mines in the north had come into the hands of English capitalists to work. The Government intended to carry out the railway themselves, but various difficulties arose in the endeavour to do this, and it eventually passed into the hands of an American syndicate, who were now constructing the line. With regard to the climate, the six months he was there, it was equal to anything in England, though perhaps, this might have been exceptional. Of course, there were fogs on the bank, which outsiders imagined prevailed throughout the island, but that was not the case; they were confined to the district of Avalon. With regard to the valne of the land through which the line passed, it seemed very suitable for settlers; and no doubt as soon as the line was made, and access provided, they would come out. The great advantage of Newfoundland, as a colony, was, in his opinion, its close proximity to England. He believed the policy of the Government, with regard to the railway, was this: they felt that the main staple industry of the country was the fisheries, and that that was somewhat precarious, and, therefore, they were bound to look ahead, and find some other source for maintaining the population. That must partly account for the change in the direction of the line, so as to develop the mines, and bring down ore to St. John's, for shipment, during the winter. The port of St. John's was undoubtedly a very good one, completely landlocked, with deep water, and very safe. It was a little difficult to get in during the winter months, when the fogs were about. Gold was found at a place called Brigus, but, according to the report of the Government geologist, not in sufficient quantity, at present, to be remunerative; possibly it might prove so with further inquiry. Those who were fond of sport, he could not advise better than to go to Newfoundland, where they would find abundance of fishing and shooting, partly large game. One point had not been alluded to by the author of the paper; that was the great hospitality of the people. He was bound to say that any one who made a visit to St. John's, and its district, would be very hospitably received, not only by the inhabitants, but also by the Governor and those in authority.

Mr. TREEVE EDGCOME said there was naturally a disinclination to visit a country where there was a prospect of such extremes of temperature as Mr. Hall had mentioned; but having himself lived in tropical climates, where much higher temperatures were prevalent during the entire year, he must say that it was very easy for Englishmen to suit themselves to any such climate. He was also particularly gratified to hear from Mr. Hall the very hopeful prospect he held out with regard to the wool industry in the country. He had been a great deal in the Australian colonies, and was quite sure that if the climate was as been described, it would be very favourable for sheep farming, and the squatting industry would one of these days be a permanent future. Mr. Hall had referred to the manner in which the French treated the colonists. That surely might be brought under the notice of the French authorities, who were very reasonable, and would no doubt listen to any representations which were made. They would all join, he was sure, in hearty thanks to Mr. Hall, for the way in which he had put so much information before the meeting.

Mr. PFOUNDES thought it very well that the author had laid stress on the great love of the inhabitants of Newfoundland for their country; and he had heard a very similar remark a few evenings ago with regard to the natives of Iceland at a meeting of the Royal Geographical Society. People might be disposed to think that because a country was in a northern latitude, the climate must be severe; but as a traveller, he might point to the fact that in all these northern inclement latitudes the people had a strong love for their homes, whilst in the eastern climes they seemed to be of quite a nomadic temperament. This was partly the case in the Australian and New Zealand colonies. As one of the general public, he knew very little about Newfoundland, but was desirous of learning something about a land he had not visited, and he must congratulate both the public and the Society on the admirably practical paper Mr. Hall had given them. It was most important in that Society that they should have practical papers of that character about foreign countries, which would tell men of business where they could use their surplus capital and energies, with adequate prospects of advantage. It was also very important that they should have practical papers bearing on the question of emigration. There was a large population of all classes who had not openings at home, and who dawdled about, not knowing where to go; and it was of some moment that they should have information placed before them, so that they might judge where it was best to take themselves and their families.

Mr. GREEN remarked that one of the most interesting parts of the paper was where Mr. Hall touched on the freedom from debt of the Government, which he believed was almost without a parallel in colonial history; and he should like to know whether that extended to individuals as well as to the Government, because if so, it must, indeed, be a delightful place to go to, for he thought prosperity must commence where debt was non-existent; and if this freedom from debt were a national characteristic of Newfoundland, it would certainly be a good place for English capital to develop itself, and for English emigrants to favour.

The CHAIRMAN said where there was a people deriving a large income from fishing and copper mines, it would follow that there would be a state of prosperity, especially as the omission from the paper of any mention of lawyers seemed to bear out that statement. In Mr. Hall's reply, he would ask him to give a little more information on the subject of wool raising; because, where the climate was so damp, as he understood it was, and the coast so decidedly rainy, he hardly thought it could be expected to compete with drier countries—such as Australia, or even South Africa. It occurred to him that, if copper of the class mentioned, the yellow sulphuret, which was so easily worked and profitable, could be procured where coal was found, and there was abundance of timber, people could be more profitably employed than in raising wool.

Mr. MORRIS asked, whether there was not a good deal of produce imported into the island, and whether when the railway was completed, there would not be every facility for growing potatoes and other kinds of vegetables, and rearing cattle, so as to save a great deal of importation.

Mr. HALL said there was a large importation of breadstuffs, but potatoes were grown in abundance, and of very fine quality. There were, however, some imported from Prince Edward's Island.

Mr. PERCIVAL asked whether the French claims, which had been referred to, would in any way interfere with the right of cultivating the soil.

The CHAIRMAN said he understood that the French claims were limited to a certain territory in the north-west, and even there they were very undefined.

Mr. PERCIVAL said he found from the paper that at one time the cultivation of the soil was a penal offence, and people were not allowed to erect houses, or build chimnies.

The CHAIRMAN said that was a long time ago.

Mr. HALL, in reply, said he was very glad his paper had elicited a discussion, which was just the result he thought such papers were intended to bring about. He was pleased to see Mr. Ridley present, and he must say that when he was in Newfoundland he was treated so hospitably that he should ever remember his visit with pleasure, and the taking leave with regret. It was quite by accident that he visited Newfoundland on his annual trip across the Atlantic, without even a letter of introduction; but notwithstanding that, he was treated with the greatest kindness. It was quite true it had been left out in the cold, but this was partly the fault of Newfoundland itself. The colony commenced as a nursery for British seamen, and in that respect England owed it a debt of gratitude. One reason why Newfoundland had not come to the front as her sister provinces in the Dominion, had been the unfortunate circumstance of the repressive policy which was at first adopted, which had dwarfed her energies to an important extent. It was only of late years—since the will and skill of the islanders, backed up by the Americans, had come more into play—that her resources had become at all developed. He was also glad to see Mr. Morris there, and to find that Messrs. Kinipple and Morris had found a better line of railway than Mr. Fleming. The line as now proposed would bisect the whole island north and south, and east and west, within the next five or ten years. At present, the whole population of the island was contained within a narrow belt of four or five miles round the coast, the interior being utterly unknown; but if it were settled as England was, it would sustain a similar population. At present, the whole interior was as much a wilderness as the interior of Africa. As to the minerals, on looking at the geological map, he was surprised to find there was scarcely any district wholly without minerals. As to the weather, perhaps his experience, like Mr. Morris's, was exceptional, but it was certainly very fine whilst he was there, and the universal testimony of all old travellers was, that the climate of the west coast and the interior was very fine. The proximity of Newfoundland to England ought to be a great inducement to emigration, and he spoke quite impartially, having no interest in the matter, and his first experience of the island having been to nearly lose his life there by shipwreck; he only spoke from knowledge of the facts, and he believed that with fair treatment, had Newfoundland been in the regular category of colonies, in the same way as New Zealand and other great insular properties of the Crown had been, it would now have a population of half a million or a million. It lay in a chief highway of the Empire; in fact, you could hardly get to North America from England without going either round it or over it. With regard to sporting, there was no doubt it was one of the finest sporting lands in the world; Lord Dunraven's testimony was quite conclusive on that point; it was unsurpassed for great game; any one who knew how to live in a "lean-to," or tent, could thoroughly enjoy himself in Newfoundland. With regard to the French claims, he thought the conduct of the French had been quite unjustifiable, and he should say the same if he were addressing a meeting of Frenchmen. The Chairman had remarked on the absence of any allusion to lawyers, but that was not from a lack of material; the courts of Newfoundland might be kept going from one year's end to another in settling these points, if competent to do so, but they were in fact points arising under the old treaties of Utrecht, and those which followed, and they had to be considered in the halls of legislation, in Downing-street, and at the French Embassy. He believed this unfortunate state of things would go on until the English Government took the initiative in the matter. He agreed with Mr. Edgcome that Englishmen could suit themselves to any temperature, and in Newfoundland you could get almost any temperature you liked by selecting different parts of the island. He did not hesitate to say, from his own experience, that when a fast express line of steamers was put on between Milford Haven and St. John's, making the passage in four days, people, instead of going to the Orkneys and the Shetlands, would go off and enjoy their hunting, fishing, and pic-nicing in Newfoundland, and he was quite certain that those who did, would have no reason to regret their choice. He had endeavoured to make his paper a useful one, and though he had not spent much time in Newfoundland; he was shipwrecked on the coast in 1849, and had been studying its history more or less ever since. Emigration was of vital importance in this overcrowded island, and it was very satisfactory to know that we had so near to us a land to which a man could go at the expenditure of a few pounds, and become an owner of a real estate instead of a pauper. His real object in bringing forward this subject was to give some practical information with regard to possible openings for British labour and capital abroad. With regard to the freedom from debt, the statement he had made in the paper was a comparative one. He believed there were some of our other colonies also out of debt—Barbadoes, for instance, was or nearly so; but to so large a colony as Newfoundland, spending large sums on improvements, it was a great credit to be out of debt. The thrifty habits of the Newfoundland farmers particularly were well known. It was an old saying there, that a farmer would not buy anything he could possibly do without, but would live on the produce of his farm as far as possible. With regard to wool-growing, his statement, again, must be taken as comparative. No doubt, portions of New Zealand would produce more wool, and of better quality, than any portion of Newfoundland; but on the interior pastures there were large patches of grass-land, which the best authorities pronounced quite as good as the pasture-land of Australia and New Zealand. No doubt the rain had much to do with the production of wool, but the rain-fall was heaviest on and near the coast. As a general rule, mining, except for copper, had been merely surface scratching; and therefore, statements with regard to the mining operations, excepting in the case of copper, must be taken, not only *cum grano salis*, but *cum multis granis salis*. In mining matters, especially, it was not right to state as facts anything which had not been substantially proved. The timber he understood to be of very fine quality, especially the pine, and very suitable for ship-building.

Mr. PERCIVAL said that Mr. Hall had not answered his question with regard to the influence of the French claims in preventing cultivation of the soil.

Mr. RIDLEY said that he might answer the question. He believed an understanding had been come to with the Government of France that they should work the mines within a reasonable distance of the coast—within half-a-mile or something of that kind—and that the French Government would not interpose any difficulty on account of the old treaties. There were no agricultural interests involved, because the French claims only extended to the right of cutting wood for fishing operations, in the season, and there was no agricultural land in the district referred to.

The CHAIRMAN then proposed a vote of thanks to Mr. Hall. He thought, not only the Society, but the people of Newfoundland, ought to thank him for so excellent a paper. One reason why so little had been known of them, was because they had not sent papers of this sort to be read at the Society. He had no doubt, in future, if they would get up a good public debt, they would be much better known than they had been hitherto. With regard to sporting, he thought it would be very useful if Mr. Hall, or some-one else, would write a few letters to the *Field* and *Land and Water*.

Mr. RIDLEY seconded the vote of thanks, which was carried unanimously.

TENTH ORDINARY MEETING.

Wednesday, February 8th, 1882; Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Campbell, Colonel Walter M. T., R.E., 99, Eaton-place, S.W.
Graham, C. Colborne, F.C.S., 29, Wilberforce-street, Hull.
Johnstone, William, Chemical Laboratory and Assay Office, Athenæum-chambers, King's Lynn.
Kennett, Richard, 8, Maddox-street, Regent-street, W.
Kinch, Prof. Edward, Royal Agricultural College, Cirencester.
Pointer, Harry, 11, Bloomsbury-place, Brighton.
Thomas, Evan William, 32, Bow-street, W.C.

The following Candidates were balloted for and duly elected Members of the Society:—

Birch, Cecil, 32, Newton-road, Bayswater, W.
Christopher, George, F.C.S., 8, Rectory-grove, Clapham, S.W.
Hilles, Malcolm W., 138, Finborough-road, S.W.
Irvine, Thomas W., 6, Aubrey-road, Holland-park, W., and 10, Austin-friars, E.C.
Jackson, Col. R. Rainsford, Ashurst, Sydenham, S.E.
Mewburn, William, Wykeham-park, Banbury.
Paynter, Lindley William, M.I.C.E., 15, Windsor-road, Ealing, W.
Pennell, George Brice, M.I.C.E., 2, Heavitree-park, Exeter.
Rees, William Andrew, 7, Cornhill, E.C.
Smith, Charles William, Westmoreland-mills, Lamb's-passage, Chiswell-street, E.C., and 33, Highbury-hill, N.
Sohn, Charles, jun., 311, Camden-road, N.
Welman, Major Charles C., The Priory, Prior-park, Bath.

The paper read was—

MODERN ORDNANCE.

By Colonel Maitland.

A great change has lately been taking place throughout Europe in the matter of armaments. Artillery knowledge has been advancing "by leaps and bounds;" and all the chief nations are vying with each other in the perfection of their *matériel* of war. As a readiness to fight is the best insurance for peace, it behoves us to see from time to time how we stand, and the present moment is a peculiarly suitable one for taking stock of our powers and capabilities. I propose, therefore, to give you, this evening, a brief sketch of the principles of manufacture of modern guns, at home and abroad, concluding with a few words on their employment and power.

The introduction of rifled cannon into practical use about 20 years ago, caused a complete revolution in the art of gun-making. Cast-iron and bronze were found no longer suitable for the purpose. Cast-iron was too brittle to sustain the pressure of the powder-gas, when its duration was increased by the use of elongated projectiles; while the softness of bronze was ill adapted to retain the nicety of form required by accurate rifling.

From among a cloud of proposals, experiments, and inventions, two great systems at length disentangled themselves. They were the English construction of built-up wrought iron coils, and the Prussian construction of solid steel castings.

Wrought-iron, as you are all aware, is nearly pure iron, containing but a trace of carbon. Steel, as used for guns, contains from 0·3 to 0·5 per cent. of carbon; the larger the quantity of carbon, the harder the steel. Since the early days of which I am now speaking, great improvement has taken place in the qualities of both materials, but more especially in that of steel. Still the same general characteristics were to be noted, and it may be broadly stated, that England chose confessedly the weaker material, as being more under control, cheaper, and safer to entrust with the lives of men; while Prussia selected the stronger but less manageable substance, in the hope of improving its uniformity, and rendering it thoroughly trustworthy. The difference in strength, when both are sound, is great. Roughly, gun-steel is about twice as strong as wrought-iron.

I must now say a few words on the nature of the strains to which a piece of ordnance is subjected when fired. Gunpowder is commonly termed an explosive, but this hardly represents its qualities accurately. With a true explosive, such as gun-cotton, nitro-glycerine and its compounds, detonation and conversion of the whole into gas is practically instantaneous, whatever the size of the mass; while, with gunpowder, only the exterior of the grain or lump burns and gives off gas, so that the larger the grain, the slower the combustion. The products consist of liquids and gases. The gas, when cooled down to ordinary temperature, occupies about 280 times the volume of the powder. At the moment of combustion, it is enormously expanded by heat, and its volume is probably somewhat about 6,000 times that of the powder. I have here a few specimens of the powders used for different sizes of guns, rising from the fine grain of the mountain-gun, to the large prisms and cylinders fired in our heavy ordnance. You will readily perceive that, with the fine-grained powders, the rapid combustion turned the whole charge into gas before the projectile could move far away from its seat, setting up a high pressure which acted violently on both gun and shot, so that a short, sharp strain, approximating to a blow, had to be guarded against.

With the large slow-bursting powders now used, long heavy shells move quietly off under the impulse of a gradual evolution of gas, the presence of which continues to increase till the projectile has moved a foot or more; then ensues a contest between the increasing volume of the gas, tending to raise the pressure, and the growing space behind the advancing shot, tending to relieve it. As artillery science progresses, so does the duration of this contest extend farther along the bore of the gun towards the great desideratum, a low maximum pressure long sustained.

When quick burning powder was used for ordnance, the pressures were short and sharp; the metal in immediate proximity to the charge was called upon to undergo severe strains, which had scarcely time to reach the more distant portions of the gun at all; the exterior was not nearly so much strained as the interior. In order to obviate this defect, and to bring the exterior of the gun into play, the system of building up guns of successive tubes was introduced. These tubes were put one over the other in a state of tension produced by "shrinkage." This term is applied to the process of expanding a tube by the application of heat, and in that condition fitting it over a tube larger than the inner diameter of the outer tube when cold. When the outer tube cools it contracts on the inner tube and clutches it fast. The wrought-iron guns of England have all been put together in this manner.

Prussia at first relied on the superior strength of solid castings of steel to withstand the explosive strain, but at length found the necessity for reinforcing them with hoops of the same material, shrunk on the body of the piece.

The grand principle of shrinkage enables the gunmaker to bring into play the strength of the exterior of the gun, even with quick powders, and to a still greater extent as the duration of the strain increases with the progress of powder manufacture. Thus, taking our largest muzzle-loaders designed a few years ago, the thin steel lining tube, which forms an excellent surface, is compressed considerably by the wrought-iron breech coil holding it, which, in its turn, is compressed by the massive exterior coil. When the gun is fired, the strain is transmitted at once, or nearly at once, to the breech coil, and thence more slowly to the outer one. Now, as the duration of the pressure increases, owing to the use of larger charges of slower burning powder, it is evident that the more complete and effective will be the transmission of the strain to the exterior, and, consequently, the farther into the body of the gun, starting from the bore, and travelling outwards, does it become advantageous to employ the stronger material. Hence, in England, we had reason to congratulate ourselves on the certainty and cheapness of manufacture of wrought iron coils, as long as moderate charges of comparatively quick burning powder were employed, and as long as adherence to a muzzle-loading system permitted the projectiles to move away at an early period of the combustion of the charge. Then the pressures, though sharp, were of short duration, and were not thoroughly transmitted through the body of the gun, so that the solidity, mass, and compression of the surrounding coils proved usually sufficient to support the interior lining. Now that breech-loading and slow powders have been introduced, these conditions have been changed. The strains, though less severe, and less tending to explosive rupture, last longer, and are more fully transmitted through the body of the gun. Sheer strength of material now tells more, and signs have not been wanting that coils of wrought iron afford insufficient support to the lining. It becomes, therefore, advantageous to thicken the inner tube, and to support it with a steel breech piece. Carrying this principle further, we shall be led to substitute the stronger for the weaker metal throughout the piece. This has been done by the Germans in the first instance, and recently by the French also. It is probable that we shall follow the same course. When I say "probable," I intentionally guard myself against uttering a prediction. It is never safe to prophesy, unless you know, as the American humorist puts it. And in this case we do not know, for a very dangerous rival, once defeated, but now full of renewed vigour, has entered the lists against forged steel as a material for ordnance. This rival's name is *wire*. Tempered steel wires can be made of extraordinary strength. A piece of round section, only $\frac{1}{35}$th of an inch in diameter, will just sustain a heavy man.

If, now, a steel tube, suitable for the lining of a gun, be prepared by having wire wound round it very tightly, layer over layer, it will be compressed as the winding proceeds, and the tension of the wire will act as shrinkage. You will readily understand that a gun can be thus formed, having enormous strength to resist bursting. Unfortunately, the wires have no cohesion with one another, and the great difficulty with construction of this kind is to obtain what gun-makers call end strength. It is of but little use to make your walls strong enough, if the first round blows the breech out. In the early days of wire this was what happened, and Mr. Longridge, who invented the system, was compelled to abandon it.

Lately, methods have been devised in France, by M. Schultz; at Elswick, by Sir W. G. Armstrong and Co.; and at Woolwich by ourselves, for getting end strength with wire guns. They are all in the experimental stage; they may prove successful; but I prefer not to prophesy at present.

The diagrams on the wall show the general construction of the modern German, French, and English heavy breech-loading guns. The Germans have a tube, a jacket, and hoops. The French, a thick tube or body, and hoops. The English, a tube, a jacket, and an overcoat, as it may be called. In each system of construction, the whole of the wall of the gun comes into play to resist the transverse bursting strain of the charge.

The longitudinal or end strength varies; thus, in the German guns, the tube and hoops do nothing—the jacket is considered sufficient. The French construction relies entirely on the thick body, while the English method aims at utilising the whole section of the gun, both ways. Of course, if the others are strong enough, there is no particular advantage in this; and it is by no means improbable that eventually we shall find it cheaper, and equally good, to substitute hoops for the "over-coat."

I fear I have detained you a long time over construction, but it is both instructive and interesting to note that certain well defined points of contact now exist between all the great systems. Thus, a surface of steel inside the bore is common to all, and the general use of steel is spreading fast. Shrinkage, again, is now everywhere employed, and such differences as still exist are matters rather of detail than of principle, as far as systems of construction are concerned.

We now come to a part of the question which has long been hotly debated in this country, and about which an immense quantity of matter has been both spoken and written on opposite sides—I mean muzzle-loading and breech-loading. The controversy has been a remarkable one, and, perhaps, the most remarkable part of it has been the circumstance that, while there is now little doubt that the advocates of breech-loading were on the right side, their reasons were for the most part fallacious. Thus, they commonly stated that a gun loaded at the breech could be more rapidly fired than one loaded at the muzzle. Now, this was certainly not the case, at any rate, with the comparatively short guns which were made on both systems a few years ago. The public were acquainted with breechloaders only in the form of sporting guns and rifles, and argued from them. The muzzle-loading 38-ton guns were fired in a casemate at Shoeburyness repeatedly in less than twenty minutes for ten rounds, with careful aiming. No breech-loader of corresponding size has, I think, ever beaten that rate. With field-guns in the open, the No. 1 of the detachment can aim his muzzle-loader while it is being loaded, while he must wait to do so till loading at the breech is completed. Again, it was freely stated that, with breech-loaders greater protection was afforded to the gunners than with the muzzle-loaders. This entirely depends on how the guns are mounted. If in siege works or *en barbette*, it is much easier to load a muzzle-loader under cover than a breech-loader. But I need not traverse the old ground all over again. It is sufficient for me to say here, that the real cause which has rendered breech-loading an absolute necessity is the improvement which has been made in the powder. You witnessed a few minutes ago the change which took place in the action of fired gunpowder when the grains were enlarged. You will readily understand that nearly the whole of a quick burning charge was converted into gas before the shot had time to start; suppose for the moment that the combustion was really instantaneous. Then we have a bore, say 16 diameters long, with the cartridge occupying a length of, say, two diameters.

The pressure of the gas causes the shot to move. The greater the pressure, the greater the impulse given. As the shot advances, the pressure lessens; and it lessens in proportion to the distance the shot proceeds. Thus, when the shot has proceeded a distance equal to the length of the cartridge, the space occupied by the gas is doubled, and its original pressure is halved. As the shot travels another cartridge length, the space occupied by the gas is trebled, and its pressure will be but one-third of the original amount. When the shot arrives at the muzzle—that is, at eight times the length of the cartridge from the breech—the pressure will be but one-ninth of that originally set up. Remember, this is on the supposition that the powder has been entirely converted into gas before the shot begins to move.

Now, suppose the powder to be of a slow-burning kind, and assume that only one-third of it has been converted into gas before the shot starts, then the remaining two-thirds will be giving off additional gas, as the shot travels through the bore. Instead, therefore, of the pressure falling rapidly, as the shot approaches the muzzle, the increasing quantity of gas tends to make up for the increasing space holding it.

You will at once perceive that the slower the combustion of the powder, the less difference there will be in the pressure exerted by the gas at the breech and at the muzzle, and the greater will be the advantage, in point of velocity, of lengthening the bore, and so keeping the shot under the influence of the pressure. Hence, all recent improvement has tended towards larger charges of slower burning powder, and increased length of bore. And it is evident that the longer the bore of the gun, the greater is the convenience of putting the charge in behind, instead of having to ram it home from the front. I may here remark, that the increased length of gun necessary to produce the best effect is causing even those who have possessed breech-loaders for many years to re-arm, just as completely as we are now beginning to do. All the old short breech-loading guns are becoming obsolete. Another great advantage of breech-loading is the facility afforded for enlarging the powder chamber of the gun, so that a comparatively short, thick cartridge may be employed, without any definite restriction due to the size of the bore.

There is yet one more point in which breech-loading has recently been found, in the Royal Gun Factory, to possess a great advantage over muzzle-loading as regards ballistic effect. With a shot loaded from the front, it is clear that it must be smaller all over than the bore, or it would not pass down to its seat. A shot thrust in from behind, on the contrary, may be furnished with a band or sheath of comparatively soft metal larger than the bore; the gas then acting on the base of the projectile, forces the band through the grooves, sealing the escape, entering the projectile, and to a great extent, mitigating the erosion of surface. This is, of course, universally known. It is also pretty generally known among artillerists that the effect of the resistance offered by the band or sheathing on the powder, is to cause more complete combustion of the charge before the shot moves, and therefore to raise the velocity and the pressure. But, I believe it escaped notice, till observed in May, 1880, in the Royal Gun Factory, that this circumstance affords a most steady and convenient mode of regulating the consumption of the charge, so as to obtain the best results with the powder employed.

Supposing the projectile to start, as in a muzzle loader, without offering any resistance beyond that due to inertia, it is necessary to employ a powder which shall burn quickly enough to give off most of its gas before the shot has proceeded far down the bore; otherwise the velocity at the muzzle will be low. To control this comparatively quick burning powder, a large air space is given to the cartridge, which, therefore, is placed in a chamber considerably too big for it. Supposing, on the other hand, the projectile to be furnished with a stout band, giving a high resistance to initial motion, a much slower powder can be used, since the combustion proceeds as if in a closed vessel, until sufficient pressure is developed to overcome the resistance of the band. This enables us to put a larger quantity of slower burning powder into the chamber, and in fact to use, instead of a space filled with air, a space filled with powder giving off gas, which comes into play as the projectile travels down the bore. Thus, while not exceeding the intended pressure at the breech, the pressure towards the muzzle is kept up, and the velocity very materially increased. Following this principle to this conclusion, it will be found that the perfect charge for a gun will be one which exactly fills the chamber, and which is composed of a powder rather too slow to give the pressure for which the gun is designed; supposing the shot to move off freely. The powder should be so much too slow as to require for its full development the holding power of a band which is just strong enough to give rotation to the shot.

Having settled that the gun of the future is to be a breech-loader, we have next to consider what system of closing the breech is to be adopted.

The German guns are provided with a round-backed wedge, which is pushed in from the side of the breech, and forced firmly home by a screw provided with handles; the face of the wedge is fitted with an easily removable flat plate, which abuts against a Broadwell ring, let into a recess in the end of the bore. On firing, the gas presses the ring firmly against the flat plate, and renders escape impossible as long as the surfaces remain uninjured. When they become worn, the ring and plate can be exchanged in a few minutes. Mr. Vavasseur, of Southwark, constructs his guns on a very similar plan. In the French guns, and our modern ones, the bore is continued to the rear extremity of the piece, the breech end forming an intermittent screw, that is, a screw having the threads intermittently left and slotted away. The breech block has a similarly cut screw on it, so that when the slots in the block correspond with the untouched threads in the gun, the block can be pushed straight in, and the threads made to engage by part of a revolution. In the French Marine the escape of gas is stopped very much as in Krupp's system; a Broadwell ring is let into a recess in the end of the bore, and a plate on the face of the breech-block abuts against it.

In the French land service the escape is sealed in quite a different manner. A stalk passes through the breech-block, its foot being secured on the exterior. The stalk has a mushroom-shaped head projecting into the bore. Round the neck of the stalk, just under the mushroom, is a collar of asbestos, secured in a canvas cover; when the gun is fired, the gas presses the mushroom against the asbestos collar, and squeezes it against the walls of the bore. It is found that this cuts off all escape.

We are at present using the Elswick method, which consists of a flat-backed cup, abutting against the slightly rounded face of the breech-plug. The lips of the cup rest against a copper ring let in the walls of the bore. On firing, the gas presses back the cup against the rounded end of the breech-block, and thus forces the lips hard against the copper ring.

It is difficult to compare the excellence of these various systems; so much depends on the care of the gunners, and the nicety of manufacture. The German and French marine methods permit the parts to be quickly exchanged when worn, but it is necessary to cut deeply into the walls of the gun, and to make the wedge, or breech screw, considerably larger than the opening into the chamber.

The Elswick plan is decidedly better in this last respect, but it requires several hours to extract and renew the copper ring where worn.

The French land service (*De Bange*) arrangement requires no cutting into the gun, and no enlargement of the breech screw beyond the size of the chamber, while it is renewable in a few minutes, merely requiring a fresh asbestos pad when worn. As regards durability, there is probably no great difference. I have been informed that with a light gun as many as 3,000 rounds have been fired with one asbestos pad. But usually it may be considered that a renewal will be required of the wearing surfaces of any breech-loader after a number of rounds, varying from six or seven hundred, with a field gun, to a hundred or a hundred and fifty with a very heavy gun. Full information is wanting on this point.

Having now decided on the material of which the gun is to be composed, and the manner in which it is to be constructed, and having, moreover, settled the knotty point of how it is to be loaded, we come to the general principles on which a gun is designed. It must not be overlooked that a gun is a machine which has to perform a certain quantity of work of a certain definite kind, and, like all other machines, must be formed specially for its purpose. The motive power is gunpowder, and the article to be produced is perhaps a hole in an armour-plate, perhaps a breach in a concealed escarp, or perhaps destructive effect on troops. These articles are quite distinct, and though all guns are capable of producing them all to some extent, no gun is capable of producing more than one in the highest state of excellence.

Thus, for armour-piercing, a long pointed bolt, nearly solid, is required. It must strike with great velocity, and must therefore be propelled by a very large charge of powder. Hence an armour-piercing gun should have a large chamber and a comparatively small bore of great length.

For breaching fortifications, on the other hand, curved fire is necessary; the escarps of modern fortresses are usually covered from view by screens of earth or masonry in front, so that the projectiles must pass over the crest of the screen, and drop sufficiently to strike the wall about half-way down, that is to say, at an angle of 15° to 20°. To destroy the wall, shell containing large bursting charges of powder are found to be particularly well adapted. Now it is clear that, for a shell to drop at an angle of 15° or 20° at the end of a moderate range, the velocity at starting must be low. Hence, for pieces intended for breaching no enlarged powder chamber is wanted; the effect on the wall is due to the shell, which must be made of a shape to hold the most powder for a given weight; and, therefore, rather short and thick. This gives us a large bore, which need not be long, as little velocity is required.

For producing destructive effect among troops, a third kind of projectile is employed. It is called shrapnel, and it consists of a thin shell, holding a little powder and a large quantity of bullets. The powder is ignited by a fuze, which is set to act during flight, or on graze, when the shell is nearing the object. The explosion bursts the shell open, and liberates the bullets, which fly forward, actuated by the velocity of the shell at the moment of bursting. Hence, to render the bullets effective, a considerable remaining velocity is requisite. The gun must therefore take a large powder charge, while, as the shell has to hold as many bullets as possible, the bore must be large enough to take a short projectile of the given weight. Thus, the proportions of the shrapnel gun will be intermediate between those of the armour-piercing gun and the shell gun.

There are certain axioms known from experience, which should be mentioned here. First, the length of the powder chamber should not be more than about 3½ or 4 times its diameter, if it can possibly be avoided, because, with longer charges, the inflamed powder gas is apt to acquire rapid motion, and to set up violent local pressures. Next, the strength of a heavy gun, as reckoned on the principle of all the metal being sound and well in bearing, should not be less than about four times the strain expected.

Again, though there are several opinions as to the best weight of shot for armour piercing, in proportion to diameter, yet amongst the most advanced gun-makers, there is a growing tendency towards increased weight. The value of $\frac{w}{d^3}$, that is, the weight in pounds divided by the cube of the diameter in inches, as this question is termed, is in the hands of the Ordnance Committee, and it is to be confidently hoped that efforts will shortly be made to arrive at a solution. In the mean time, from about ·45 to ·5 appears to be a fairly satisfactory value, and is adopted for the present.

Lastly, it may be broadly stated, that with suitable powders, a charge of one-third the weight of the shot demands, for most profitable use, a length of bore equal to about 26 calibres; a charge equal to half the weight of the shot should be accommodated with a bore of about 30 calibres; while a charge of two-thirds the weight of the shot will be best suited by a bore 35 calibres long. Of course, in each case, greater length of bore will give increased velocity, but it will be gained at the expense of additional weight, which can be better utilised elsewhere in the gun.

The amount of work performed by gunpowder, when exploded in a gun, is a subject which has engaged a vast quantity of attention, and some highly ingenious methods of calculating it have been put forward. Owing, however to the impossibility of ascertaining how fast the combustion of large grains and prisms proceeds, a very considerable amount of experience is required to enable the gun-maker to apply the necessary corrections to these calculations; but, on the whole, it may be said that, with a given charge and weight of shot, the muzzle velocity may now be predicted with some accuracy.

You now have the chief data on which the designer bases his proposals, and lays down the dimensions of the gun to suit such conditions as it may be required to fulfil. In actual practice, the conditions are almost always complicated, either by necessities of mounting in particular places, such as turrets and casemates; or by the advantages attending the interchangability of stores, or other circumstances; and it requires great watchfulness to keep abreast of the ever-growing improvements of the day.

I will now conclude with a few words on the power of heavy guns, when employed in various ways. The first consideration is accuracy of fire. No matter how deadly the projectile may be, it is useless if it does but waste itself on air. Accuracy is of two kinds—true direction and precision of range. All modern guns are capable of being made to shoot straight; but their precision of range depends partly on the successful designing of the gun and ammunition, so as to give uniform velocities, and partly on the flatness of the trajectory. The greater the velocity, the lower the trajectory, and the greater the chance of striking the target. Supposing a heavy gun to be mounted as in the fortresses round our coasts, and aimed with due care, the distance of the object being approximately known, we may fairly expect to strike a target of the size of an ordinary door about every other shot, at a range of a mile and a half. Here we have carriages mounted on accurately levelled platforms; we have men working electric position finders, and the gunners live on the spot, and know the look of the sea and land round about.

Now, consider the case of guns mounted in ships. You at once perceive the difficulties of the shooter. Even supposing the ship to be one of our magnificent ironclads, solid, steady, yielding little to the motion of the water, yet she is under steam, the aim of her guns is altered every moment, some oscillation is unavoidable, and she can only estimate the range of her adversary. Great skill is required, and not only required, I am glad to say, but ready to hand, on the part of the seamen gunners; and low trajectory guns must be provided to aid their skill.

If we go to unarmoured ships of great tonnage and speed, we shall find these difficulties intensified; and if we pass on to the little gunboats, advocated in some quarters for attacking iron-clads in a swarm, we shall find that unsteadiness of platform in a sea-way renders them a helpless and harmless mark for the comparatively accurate practice of their solitary but stately foe.

The destructive power of guns is little known to the general public, and many wild statements are sometimes put forward. Guns and plates have fought their battle with varying success for many years. One day the plate resists, another day the gun drives its bolt through. But it is frequently overlooked that the victory of a plate is a complete victory. If the shot does not get through, it does practically nothing. On the other hand, the victory of the gun is but a partial triumph; it is confined to a small arc. I mean, that, when the plate is struck at an angle exceeding 30° or so, the shot glances harmlessly off; while, even when perforation is obtained, it is at the expense of the more deadly qualities of the projectile, which must be a nearly solid bolt, unable to carry in with it heavy bursting charges of powder, or destructive masses of balls.

About six years ago, an experiment carried out at Shoeburyness taught a lesson which seems to be in danger of being forgotten. We hear sometimes that unarmoured vessels are a match for ironclads and forts; and I will conclude this paper with a short extract from the official account of the results of firing shrapnel shell at an unprotected ship's side. I shall say nothing of boilers and magazines, but shall state simply the damage to guns and gunners.

A target was built representing the side of a certain class of unarmoured ships of war; behind this target, as on a deck, were placed some unserviceable guns, mounted on old carriages, and surrounded by wooden dummies, to represent the men working the guns. The attacking gun was a 12 ton 9-inch muzzle-loader, of the old despised type, and the projectiles were shrapnel shell. The charges were reduced to represent the striking force at a range of 500 yards. Two rounds did the following damage inside, besides tearing and ripping the ship's side in all directions.

1st Gun.—Seven men of detachment killed.

2nd Gun.—Carriage destroyed; six men blown to pieces, all the remainder of the detachment severely hit.

3rd Gun.—No damage to gun or carriage. Five men killed, one blown to bits, and one wounded in leg.

4th Gun.—Gun dismounted. The whole of the gun detachment blown to pieces.

That is the amount of destruction achieved in an unarmoured ship by two rounds of shrapnel shell.

I beg to thank you sincerely for the kind attention you have given to me this evening.

DISCUSSION.

Gen. Sir JOHN ADYE, K.C.B. (Surveyor-General of Ordnance), said he should like to refer for a few moments retrospectively, to the great development of artillery science, which commenced 25 years ago, and which, even now, hardly showed signs of having reached finality. England was amongst the first to use rifled ordnance, and at the outset the breech-loading system was adopted, the result being that we obtained guns with range and power far beyond anything known before. The system was consequently adopted with enthusiasm, and between 1858 and 1862, an expenditure of 2½ millions sterling was incurred in the manufacture of armaments for our fleet and fortresses. But although these guns had many excellent qualities, they soon developed serious defects; they were found to be delicate, liable to get out of order at critical moments, and accidents occurred to the men who served them. The result was, that a decided change of opinion took place; the officers and men, to some extent, lost confidence in their weapons, and were as anxious to get rid of them as they had been to obtain them. This led to the Government instituting careful inquiries; there were the Armstrong and Whitworth competition in 1863, various trials in 1864 and 1865, and committees appointed between 1865 and 1870, who all pronounced a unanimous opinion that a muzzle-loading system ought to be introduced. In consequence of this, for several years all guns up to 80 or 100 tons were made on that system. The Germans, on the other hand, adhered to the breech-loading system throughout, though in their early experience they met with many difficulties as we had done, and in the great Franco-German war, many of their field-guns, though firing small charges, broke down, whilst the siege-guns before Paris were weaker still. Indeed, Herr Krupp himself wrote to the *Times* in 1878, saying that after that war the German Government remodelled the whole of its field and siege breech-loading artillery. Both the War Department and the Admiralty in 1870, and again in 1875, expressed their confidence in our armaments, both as regarded power, range, and accuracy. In 1874 and 1875, in fact, England held a leading position in respect to artillery. At that time, no doubt, many people hoped we had approached finality; but their hopes were disappointed, for about that time another great stride was taken in artillery science, the full effects of which had not yet been realised. This great progress was due very much to the researches of the Explosive Committee, and partly to the experiments of other nations. That committee had been sitting from 1868 to the present day, and had gradually discovered that guns could be made of far greater power, range, and velocity than those manufactured seven or eight years ago; indeed, speaking roughly, he might say that the guns of to-day, whether muzzle or breech-loading, were nearly double the power of those of the same weight made eight years ago. Some people were under the impression that a muzzle-loading gun was, in itself, weaker than a breech-loader, but that was not so. Guns could be made on either system, practically identical in weight and power; rapidity of fire, he believed, was rather on the side of the muzzle-loader. But it was found that these new types of guns required to be made of immense length and with large chambers, firing heavy charges, and in such cases there was an evident advantage in loading at the breech. At the same time, it is hoped that the introduction of improved slow-burning powder will prevent the distressing accidents which sometimes occurred in early days. It was quite right, under such circumstances, that Government should institute careful experiments, with a view to the introduction of heavy breech-loaders; but the progress of re-armament could not be very rapid. It was a work of time and expense, and he believed, also, that new ships would be required for the very large guns of the new type, so that re-armament must be gradual. With regard to the introduction of steel, he thought caution should be used; he could quote many accidents which had occurred to guns made entirely of steel, in particular two which had happened to Krupp's guns, one in Constantinople and another recently on board a German ship. So far as he knew, the wire gun, which had been under experiment by Sir William Armstrong, had given very remarkable results, and might possibly lead to a satisfactory solution of this matter. The Government had recently established an Ordnance Committee, for the purpose of considering the scientific questions involved in all these matters, consisting of distinguished officers of the artillery and Navy, and of two eminent civil engineers, one of whom he was pleased to see in the chair. This committee had a large accumulation of knowledge, at their disposal, gathered both at home and abroad, and there was reason to hope that their reports would give confidence to the public. The Admiralty and the War Department were in complete accord on these matters, and the committee would be glad to receive assistance from civil engineers or others who had practical knowledge. There was a determination on the part of the Government that, in the future, as in the past, England should hold a leading position as to its armaments, and be prepared to guard the interests of the Empire in every part of the world.

Professor ABEL said that though he had witnessed the development of rifled artillery from its earliest stages, and also the successive battles between breech and muzzle-loaders, he should not have felt competent to speak on this subject but for the fact that he was somewhat intimately acquainted with the propelling agent employed in guns, and also with the material used in their construction. In reference to what Colonel Maitland had said in his paper with regard to the preference shown by England for wrought iron, its employment was then a matter of necessity, and not of choice, because when rifled guns were first adopted, though we knew almost as much as we do now about the working of malleable iron in large masses, the knowledge concerning the production and treatment of large masses of steel was very limited. In fact, practically almost the only person who had successfully dealt with the production of cast steel in large masses was Krupp, of Essen, and even in his hands it was still a child, and the material he then produced was confessedly often unreliable. The English Government, advised by one of the most distinguished engineers of the country at that time, constructed rapidly and readily guns of wrought iron of considerable size, and which were, at that time, as superior in point of uniformity to cast steel guns as they were in point of strength to cast iron. Since then, we had learned much as to the properties of steel and how to deal with it; and, thanks to the development of the Bessemer and kindred processes, we could produce steel of high and uniform quality, and of the requisite softness and temper; and no one could now doubt that steel competed successfully with wrought iron as a material for ordnance. But even now, if it had not been for the improvements effected in the manufacture of gunpowder, steel would probably not be so applicable as it was for ordnance, since, even in its best form, it was, he believed, not so capable of resisting the sudden strains inflicted by violent powder as malleable iron; Colonel Maitland had told them that long after it was used abroad, it was found necessary to strengthen the breeches of steel guns by envelopes of wrought iron. The present improvements in gunpowder had originated in the researches to meet the requirements of the earlier rifled guns, carried out by the earliest Explosive Committee, of which he was a member; and the broad principle was laid down, which had up to the present been adhered to, that the proportions of the powder constituents having been fixed upon as being calculated to give the maximum development of force for a given weight of material, it was advisable, if possible, to moderate its action, not by altering its composition, but by modifying its physical and mechanical characteristics. The improvements alluded to by Colonel Maitland had been entirely of that nature; great attention had been paid to means for regulating its density and hardness, and the size of the individual masses, and to other minor points necessary to secure uniformity, a result the attainment of which was by no means so easy as might be supposed. By these means they had succeeded, at first very gradually, but lately more rapidly, in moderating the rapidity of action of gunpowder, until it became comparatively manageable. But even these improvements introduced difficulties which it required all the skill of the manufacturer and the chemist to overcome. Amongst the difficulties incident to the use of large charges, was the erosion of the surface of the bore; and although this was partly overcome by means of bands or discs of soft metal, the erosion of guns was still a serious question which was taxing all their energies and skill to meet. Colonel Maitland had given some interesting views as to the effect of the retardation of the shot, and the gradual development of the force of the powder in large charges. The idea of retardation of the shot, referred to as novelty, was mooted many years ago, and several plans were brought forward to effect it. With one or two exceptions, they were not very practical, and their object was scarcely the same as that aimed at by Colonel Maitland. But it did appear that the principle of retardation was applied in the earlier rifled service breech-loading guns, which fired lead-coated projectiles. The forcing of the soft metal coating into the rifled grooves had a retarding effect on the projection of the shot, and it was this very fact that led to the discovery of the necessity for moderating the rapidity of explosion of the powder then used.

Colonel HOPE, V.C., wished to correct a slight misapprehension on the part of Colonel Maitland, with regard to Mr. Longridge having abandoned his steel-wire principle. From a letter received from him only yesterday, it appeared that he was still convinced that his principle was correct, and he was only afraid that Sir William Armstrong would fail because he was diverging somewhat from it. He had listened with great pleasure to the remarks of Sir John Adye. It was quite true, as he said, that at one time England was ahead of all other countries in heavy ordnance, but, nevertheless, he thought then, a he did still, that those immense guns were constructed on wholly erroneous principles; and that seemed to be now acknowledged, because those guns were already obsolete. With regard to the gunpowder, the composition was the same, and if there were any difference in the strength, the large sized powder was the weaker. You had only to stand behind one of these now obsolete guns when fired, and you saw grains of powder passing through the air outside the gun, showing that the whole of the powder was not converted into gas inside, and of course, any portion not so converted was absolutely wasted. The only gain obtained by increasing the size of the grains was that you humoured the weakness of the gun by making the combustion slower. If the gun were strong enough, the more violent the powder, giving the more complete conversion into gas, the better the result, as you got something of the effect of a blow as well as a push. If he mistook not, the powers of the Ordnance Committee were limited to certain matters which were referred to them; and therefore it was not of the nature of a scientific committee, able to undertake original research, and it did not at all follow that any system which might be ultimately approved would be the best, or the one which they would themselves have approved had their powers been larger. He had heard with great pleasure the statement that the Government would welcome assistance from all comers, which was a complete change of affairs within one or two years. Theoretically, Government were always ready to receive assistance from anybody, but it was under conditions that few people would be willing to accede to. The consequence was that if any one were foolish enough to offer to assist the Government, they insisted on his surrendering all his secrets, and assisting in every possible manner, receiving only such reward as the Government department itself should fix. He never could see why guns, ships, and kindred matters should be treated in a different way to every other question of a similar nature. If the War Office required an acre of land to increase an existing fortification, it could take it, but it had to pay a fair price, to be fixed by arbitration; and why should it arrogate to itself the right to seize a man's invention, and use it, and pay him whatever crumb some one in authority chose to fling to him? He had just had the misfortune to lose, by death, one of his earliest friends, Sir William Palliser, a man who had made many inventions, some of which were taken up by the Government, and some were not. One of these was the converting of old smooth-bore cast iron guns into rifled ordnance. About 2,500 of these guns were in constant use, and down to a very recent period, at any rate, not one of them had ever burst, or [caused a serious accident; and he thought it was a great pity that this system had not been applied to larger guns, such as the one shown on the drawing. This principle was to line a cast iron gun with a wrought iron tube, and he thought it a pity that so cheap and easy a system had not been adopted instead of the more costly and cumbrous one which had already broken down. There was no doubt that foreign countries were ahead of us in the use of steel, with the single exception of this system of steel wire, which he did not profess to understand. Some specimens of guns he had seen on the continent were altogether in advance of anything he had seen at home, and a gun, 18 feet long, was now being made for him on the continent, of cast steel tempered in oil, which was altogether superior as regards metallurgy to anything he had seen in England.

Professor ABEL said he had endeavoured to explain that the composition of powder had been in no way changed, and the total force developed. With regard to burning particles being seen to come out of the gun, he believed the same thing occurred with the quickest and most violent powders used; but it was only a very small proportion of the charge. It was scarcely the correct view of the cause of modifications effected in gunpowder to say that they had been introduced to humour the weakness of structure of the guns; their real object and effect were to develop the full power of those guns. Artillerists now obtained velocities never dreamed of before, and with much less maximum pressure on the gun.

Mr. SCOTT MONCREIFF having referred to the admirable manner in which Colonel Maitland had treated the subject, desired to call attention to what he considered an omission, in its not having set forth the researches of Mr. Robert Mallet with regard to malleable iron, which had been the foundation of all subsequent knowledge on the subject. He also thought the name of Mr. Fraser, of Woolwich, ought to have been referred to.

Mr. WOLSTENCROFT desired to call attention to the experiments of Mr. Adamson, of Manchester, some years ago, on plates of Martin-Siemens steel, Low Moor, and Staffordshire iron, showing the great superiority of the steel plates in withstanding the explosive force of gun-cotton. The results were published in a pamphlet, which could be obtained from Mr. Adamson.

Major CHARLES JONES said it was quite true that there were a large number of the Palliser guns in the service, but they were all of a moderate size, the charge of the largest being 10 lbs. He believed the system had been recently applied in America to larger guns, but not very successfully, two having burst very recently. With regard to an observation of Colonel Maitland's, on the inaccuracy of fire from gunboats, he thought he had gone further than the gentleman he referred to intended. The vessels he advocated were cruisers, ranging from 2,000 to 3,000 tons burden, and they could scarcely be regarded as small boats, bobbing about on the surface of the ocean; in fact, the accuracy of their fire would be approximately as great as that of an ironclad. The argument was, that you would not have only one, but several cruisers fighting an ironclad, carrying an equal number of guns, moving with greater rapidity, choosing their own range, and concentrating their fire, whilst the armour-clad vessel would have to disperse her fire and aim at a much more rapidly moving object. There could be no question about the damage done to an unarmoured vessel by heavy ordnance, but the damage done to an ironclad, although fewer shots got through, was not quite so small as the remarks made might lead one to suppose. When you got a Palliser shell, or even a Palliser shot, through, those projectiles themselves broke up, and not only so, but they carried with them pieces of the plate and backing, and bolts through in a shower, and the effect would be practically the same as the bursting of a shell inside an unarmoured ship. As regarded the ribbon gun, two were made, to begin with, and the first one, made in 1879, had stood very large charges and showed no signs of failure; that was a 6-inch, but the one now under experiment was 10·263 inch. One reason why guns had grown in length was the advantage which had been found to arise from air spacing, firing the charge in a chamber not completely filled. That result was deduced from the experiments of Prof. Abel and Captain Noble, showing that pressure in a closed vessel was due to the density of the charge; as the density increased, so did the maximum pressure, and it naturally followed that by giving the charge in the gun less density, not filling the chamber, you were able to keep down the maximum pressure; but in order to get the full effect of the powder, it was necessary to lengthen the bore; and that, again, led to the adoption of enlarged chambers. That was begun some years ago, by Captain Noble, in order to give air-space, without unnecessarily encroaching on the bore.

The CHAIRMAN said that the more he considered the question of artillery, to which his attention had been directed for several years before he joined the Ordnance Committee, the more he was struck with the difficulties that surrounded the subject. A weapon was required which should not only be a source of danger to the enemy, but should also be so absolutely safe as to inspire the utmost confidence in those who used it. As a civil engineer, he was accustomed to deal with large pressures, as they were considered, of elastic vapours. Steam was now being used at a pressure of 1,000 lbs. to the square inch, which was thought very great, and great precautions were taken against accident. But this pressure sank into insignificance when compared to that in the chamber of a large gun, which was very commonly 17 tons to the inch, or 38,000 lbs., and sometimes went up to 25 and even to 30 tons. The problem was, to make a vessel which should bear this enormous pressure, without exceeding the elastic limit of the material. They all knew now that which was not so well known formerly, that if the bore of the gun were surrounded by a mere block of metal, with all the parts in a quiescent condition, without any initial strain, the pressure which came upon the interior of that block had to be resisted by the immediately neighbouring metal, without that metal receiving any substantial aid from the metal further removed from the centre; in that way the interior metal yielded, and was fissured, and when once this occurred the fissure increased until the whole gun was rendered unserviceable, or, perhaps, burst explosively. It was, therefore, found impossible in gun-making to deal with metal in the ordinary condition in which an engineer was content to deal with it, and therefore recourse had been had to that which was known many years ago as a mode of obtaining the aid of the whole of the metal in the construction, when pressures such as obtained in the Bramah presses were employed; and it was on that principle that all modern guns were made. With respect to the wire or ribbon gun, while following the example set by the reader of the paper, and not attempting to prophesy until the event had happened, he could not help thinking that it would be well to investigate this subject thoroughly. Whether it would succeed or not he would not say, but the experiments which had been made were favourable. There was great simplicity of construction, and great certainty in some respects. You had not to deal with those difficulties which arose when metal was shrunk on at a high temperature, though he must admit that the great practice and skill in the gun factories, and the great knowledge of their superintendents, enabled this to be done with nearly absolute certainty. But when dealing with material in the cold state, as in the easily-manageable form of a ribbon, it was obvious that you could control the tension put upon it, you could wind it on as you wished, and if you did not like it, you you could undo it. Again, you could not get any serious local latent defect, such as it was impossible always to avoid in a large mass of metal. If in the ribbon there were defects, they would only be local; and where you had twenty coils one over another, surrounding a 10-inch gun, it was not likely that the defects would be cruel enough to occur in the same radial line in the whole twenty convolutions, or indeed that more than one of them would thus occur. Probably nothing but the most severe test would tell whether that construction which appeared so substantial, when first made, would be substantial after the concussions arising from repeated discharges; but he thought one might be very hopeful about it. He had been surprised to hear one observation from Professor Abel, which, in any view, he was sorry for. He should be very sorry to suppose that Professor Abel was wrong, but still more sorry if he were right. He referred to his observation that steel was less competent than wrought iron to resist a sudden action upon it. There was steel and steel, and if the observation had been made by some one who was not acquainted with the subject, and when thinking of steel had present to his mind a file, which would break in two if dropped on a stone floor, he should not have paid any attention to it; but, coming from a gentleman of Professor Abel's experience as a chemist and a metallurgist, he was surprised to hear it. He should certainly have said that steel was more able even than wrought iron to withstand percussive action. But he thought it was clear that, whether in the form of wire, or of hoops, or of forged pieces, owing to the changes in the powder and in other ways alluded to by Colonel Maitland, the large guns of the future would probably be made of steel, a metal which certainly would give a strength not to be obtained from wrought iron. Reverting again to the ribbon gun, he might remark that in a gun ordinarily weighing 25 tons, one might look in the ribbon mode of construction for a saving in weight of four to five tons, or if the weight were the same, to a proportional increase in strength. A question had been raised as to the longitudinal strength of ribbon guns, and reference had been mada to three modes generally adopted for insuring it—the French, Sir William Armstrong's, and the mode adopted at Woolwich; probably any of these would suffice, but the French appeared to be cumbrous, and if the drawings he had seen were accurate, he feared there might be a failure, not on account of the material, but because there were sudden changes of form which must lead to ruptnre. This, however, was a mere matter of construction, which could be easily altered, and might be only an error of the draughtsman, who prepared the drawings he had seen.

Colonel MAITLAND, in reply, said he should not like any one to think he had omitted Mr. Fraser's name from any personal feeling. He worked with him every day, and he thought it would be almost like self-praise to mention his name particularly. With regard to Mr. Mallet, Tubal Cain, and others, he had not gone back so far. It was said that retardation for regulating the consumption of powder was old, but it was so new that until a few days ago it was not believed in. Like many other discoveries, people said at first there was nothing in it, and then they said they knew it all the time. In breech-loaders, until very recently, they had always had large air-spaces in order to mitigate the violent effects of the powder. But the air-space was waste; if you filled it with powder it was more useful, and if you could hold the shot back so as to consume a slower powder at a steady pressure you could use a much larger charge. The other day he fired a 10·4-inch gun with 231 lbs. of powder and a large air-space on the old principle, and the velocity obtained was about 1,950 feet. He then fired it with a very large charge of slow powder and strong band, and got 2,150 feet. With regard to the gunboats and cruisers, Major Jones seemed to know whom he alluded to, but the views he referred to were put forward by several others; and his special argument was against small gunboats, which were supposed to come out in swarms to attack an ironclad. He believed about half of them would be sunk. He heard an interesting lecture lately on the subject Major Jones alluded to, that of attacking an ironclad like the *Inflexible* by three large cruisers. An eminent engineer, he met coming out, said it was a very interesting subject, and he asked him which he would rather be in, the armoured or the unarmoured ships. His reply was, that in the present state of science he should prefer the ironclad ships, and he quite agreed with him. The principle of enlarging the chamber of guns, so as to hold a larger charge of powder, was thoroughly worked out in 1873 in the Royal Gun Factory; Major Jones appeared to think it was due to Captain Noble. (Major Jones disclaimed this, and explained that he referred only to the use made of enlarged chambers for air-spacing). Colonel Maitland said that in that case he had nothing to add, except to offer thanks for the kind attention given to him.

The CHAIRMAN then proposed a vote of thanks to Colonel Maitland, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

AGRICULTURE IN ROUMANIA.

The total area of Roumania, exclusive of the Dobrudscha, is 29,650,000 acres, and the country is divided into three zones. The first, or foreign region of the Carpathians, which includes much good pasturage, even up to the summits of the mountains, where the population is scanty; the second, the uplands, devoted to pasturage, vineyards, and fruit orchards; and the third, the rich valley of the Danube, where cereals and colza are grown. The soil in this region is very rich—nearly similar in nutritious properties to the celebrated black earth of Russia. Consul-General Schuyler states, in his report, recently issued, that less than one-half of this area is under cultivation, or in pasture; of the remainder, 5,000,000 acres are covered with forests, and nearly 10,000,000 acres are waste land. All this, however, is fit for cultivation. Irrigation, and dykes, to prevent the overflows from the mountain streams, would render even much more land fit to be tilled. Labour is scarce, especially at harvest time; the population is too small for the country, and many of the proprietors have larger estates than they can properly work. By the rural law of 1864, the serfs were freed, and were granted lands taken from their masters; about one-third of the estates were thus taken, and were distributed among about 600,000 families. The proprietors were indemnified by the State, which assumed the indebtedness of the peasants, and gave thirty years in which to pay it off. The total number of proprietors, including peasants, would now amount to about 650,000, and the average size of the peasant property is from 10 to 15 acres; the size of the larger estates varies very considerably; there are two or three of 75,000 acres and above, and there are many which exceed 5,000 acres. Between these large estates and the peasant properties, there is nothing, except a few medium properties in Moldavia, of from 250 to 600 acres. By the confiscation of the church property, which was some of the best land in the country, the State became possessed of a very vast domain. This it is gradually selling off to the peasantry on very easy terms — one third to be paid down, six per cent. interest and six per cent. sinking fund, to be paid annually on the other two-thirds, so that the debt can be entirely paid off in twelve years. The amount still in the hands of the State is about 3,850,000 acres, of which about 2,630,000 are cultivable, 1,084,000 are forest lands, and the remainder are marshes and swamps. This domain is rented by the State, but when the lands cannot be rented, they are worked on account of Government. Foreigners were formerly not allowed to purchase lands, but this right has now been given by treaty to the subjects of several European nations. Jews, however, are still prohibited from holding rural properties. The constitution forbids the colonisation of Roumania by foreign races, but this does not apply to Italians, Spaniards, or others of the Latin race. Few of the large proprietors work their own lands, except in Moldavia, the lands being either farmed out on short leases, or what is the general practice, worked by peasants on the "metayer" system. The peasants, also, frequently hire additional land from their proprietors, and in some cases they even purchase it, and form associations for the purpose of working the land on a co-operative plan. The average annual agricultural production is as follows:—Maize, 42,300,000 bushels; wheat, 28,500,000; barley, 10,100,000; rye, 3,000,000; oats, 1,500,000; buckwheat, 177,000; colza, 1,200,000 bushels. The principal of the rotation of the crops generally prevails in Roumania, it being usually maize, wheat, and fallow, but there are many farms where the land is never idle, but is under constant cultivation. When beans, lentils, or peas are grown, they usually precede the wheat crop, as they are supposed to leave the ground in good condition. Although, in general, the methods of agriculture are the most primitive, there is yet a tendency, especially among the larger proprietors, to introduce machinery and improved implements. Owing to the imperfect methods of cultivation, the largest amount of seed used, the wasteful sowing, and the total neglect of manure and fertilisers, the profit per acre, after deducting the cost of labour, seed, &c., for wheat, does not exceed, on an average, 25s.; for barley, 10s.; rye, 29s.; maize, 66s.; and for oats, 35s.; these figures do not include the rent or the interest on the land. The average value of good arable land in Roumania may be taken at about £5 the acre; it has risen since the institution of the Credit Foncier, by which loans can be obtained at a lower rate of interest—7 to 8 per cent., where formerly 12 to 16 per cent. was demanded. The renting value of farming land is, on the average, 4s. an acre, though some land would rent as high as 12s. an acre. In addition to this, there is a land tax of 6 per cent. on the revenue, estimated generally on the rent, besides the road taxes, and poll taxes. Maize forms one of the great staples of Roumania; not only is a very large quantity exported, but it furnishes to the peasantry their chief article of food, usually in the form of a thick porridge, or of a half-baked bread called "mamaliga." The cultivation of the vine, which grows wild in Roumania, is rapidly increasing in importance, considerable improvements having been made in the method of culture by the large proprietors; and certain of the wines, such as the white wines of Dragashaori and Cotnari, and the red wines of Odobest and Dealu-Mare, are considered of excellent quality, and largely consumed. There is also a good wine called "mischet," which preserves the aroma of the Muscat grape, without its sweetness. In 1873, the latest year for which it appears the figures could be obtained, there were 4,593 communes, where wine was produced, the vineyards covered 252,147 acres, and belonged to 181,045 proprietors. The maximum value of an acre of vineyard, in the district of Prahova, was about £38, and the minimum value in the district of Mehedintsi was about £2. At one time the honey and wax of Roumania were famous throughout the east, but apiculture has greatly fallen off of late years, although both the climate and the flora are very favourable to its development. Consul Schuyler states, with reference to the breeding of animals, that though the conditions for breeding are very favourable, very little attention is paid to this branch of rural economy; more attention is bestowed on the breeding of animals in Moldavia than in Wallachia. The Roumanian horses are small, quick, and support great fatigue, but they are seldom used in agriculture, except in places for treading out the grain, flails being almost unknown in Roumania; small grey cattle and buffaloes are generally used for field labour. There is in Roumania a Ministry of Agricultnre, Commerce, and Public Works, and under its charge is an agricultural school, at Ferestren, near Bucharest, as well as a factory school for the manufacture of agricultural machines, at Jassy, four large nurseries of fruit and forest trees, a model stud at Nucetu, besides agricultural lectures in the semi-naries, agricultural exhibitions, and horse races.

CULTIVATION OF LIQUORICE.

An article in the *Oil and Drug News* contains the following particulars on the cultivation of liquorice *(Glycyrrhiza glabra)*:—Large exports of this root are now made from Spanish seaports to the United States. France also consumes large quantities in the manufacture of liquorice-paste. This root is used in America principally for sweetening in the manufacture of plug and other kinds of tobacco; it is also used in the manufacture of drugs and the preparation of medicines. It grows wild on the lower lands, in marshy ground, and on the banks of rivers. Probably the best quality obtained in Spain is found in the provinces of Arragon, Murcia, and Toledo. The very best Spanish liquorice root is found near the margin of the Ebro, in Arragon; the next in point of quality is obtained near Cordova. When it once takes root it is almost impossible to eradicate it. It grows in many countries, and varies in quality according to soil. Spanish liquorice differs quite materially in the several provinces, the principal variations being that in some parts the bark is red, brown, or light colour, the inside varying from light yellow to brown. The proportions of saccharine and starch vary also. Many kinds are fibrous, while others are almost as hard as wood. The ground is culled at intervals of three, four, or five years, according to circumstances, by digging trenches, pulling everything visible as long as possible, until it breaks. After a year or two it shows above the ground with a little stem. From the time this stem appears, until the flowers have all fallen, the root is not in condition to extract, for the sap does not return to the roots until then. Each year that the ground is culled, the quantity of roots and tops increase until the ground is unfit for cultivation of any kind. It is from September till March that the root is gathered, and goes through a process of drying, or curing, before it is considered marketable. Liquorice root is also found and gathered in Asiatic Turkey, Greece, Italy, and the Sicilies, and in Spain. In Italy and the Sicilies very little, if any, is exported as root, it being used in the manufacture of roll or stick liquorice. There is a small section in England which produces a limited quantity. Liquorice root is also grown in several parts of the United States, but the quality is not such as to give it value. The quality of root produced in the different countries is as follows:—Asiatic Turkey, decidedly bitter; Greece, bitter, but not so bitter as Asiatic Turkey; Sicily, sweet, but less so than Spanish; Spain, rich and sweet; Italy, richest and sweetest of all. Malaga has not, up to the present season, been considered an important shipping port for the root, Seville, Alicante, Barcelona, and Bilbao being nearer the producing districts. The value of this root does not admit of its being increased in crop by cultivation, and the quantity gathered depends greatly upon the severity or mildness of the winter. If severe, it lessens the quantity gathered. Again, if other crops are good, labour being scarce less root gathered, consequently prices are higher. There are one or two large French establishments in Spain for making paste and stick-liquorice—one in Seville and the other in Saragossa, besides a few small Spanish establishments also engaged in the manufacture of liquorice-paste. In connection with this subject of the cultivation of the liquorice plant, it may be stated that an attempt is being made in Auckland, New Zealand, to establish its growth. If its cultivation proves successful, it will be taken up on a very large scale by extensive landowners; for this purpose a large quantity of the root has been imported and distributed throughout the country districts.

FISH GUANO IN NORWAY.

Consul-General Crowe remarks, in his report upon the trade and industries of Norway, that a large business is rapidly springing up in the manufacture of fish guano, and that the heads, bones, and refuse of all kinds of fish, which a few years ago were wasted, are now advantageously utilised in the manufacture of this article. The first factory was established for making this kind of guano in Lofoden about 1860, and since then their number has increased from time to time. The Norwegian fish guano is made by grinding fish offal, composed chiefly of heads and bones of the cod, or *gadus morrhua*, which are collected during the large cod fisheries. The heads and backbones are removed previous to curing, and the following substances are likewise used in the manufacture of guano—damaged dried fish, dried and split cod-fish damaged by sea-water, herring heads, damaged herrings, all kinds of fresh fish, and flesh of whales and Greenland sharks; but the different descriptions of raw materials used require a different mode of preparation. The Norwegian manufacturers make their guano almost exclusively from the heads and spines of the cod-fish, while offal from herrings and soft parts of cod and other fish are but seldom utilised for this purpose, as the expense of producing guano from the latter substance is greater, and the product of an inferior quality. The manure which originally appeared for sale under the name of Norwegian Fish Guano, was made exclusively of the first-named substances, and according to chemical analysis, is composed of the following elements:—Water, 13 per cent,; organic substances (of which 8 per cent. is nitrogen, and 7·6 per cent. ammonia), 49·3 per cent.; and inorganic substances (of which 14·9 per cent. is phosphoric acid), 37.7 per cent. This larger proportion of fertilising agents has led to its being held in such high favour in the agricultural markets. It is manufactured as follows:—The heads and bones of the fish are collected at the fishing places, and dried on the hills in the open air, before putrefaction sets in, the heads being tied in bundles of twenty each, and the bones carefully separated. After having been sufficiently dried, so as to be no longer exposed to the risk of putrefaction, they are carried into the manufactory, where they are cut into small pieces, thoroughly dried on plates in a kiln, and crushed, all by means of machines especially constructed for this purpose; finally, the mass is ground between large millstones to the fineness of common flour. The heads and bones are crushed separately, but mixed together during the grinding process. As a rule, one sack, containing 204 lbs. of bones, is mixed up with five sacks of heads; this turns out the best result. When guano is to be produced from damaged salt fish and herrings, the mode of manufacture is different, as the fish is not capable of being dried when containing salt, which must be previously removed. This is effected by means of a cylindric caldron of iron, furnished with the necessary cranes and openings, for filling in and taking out the raw material; after that the cylinder is filled, steam is led into the bottom of the same from a boiler, and the mass exposed to a pressure of 30 lbs. for about half-an-hour, sufficient to separate the salt, which runs off through a channel in the cylinder. The mass is then taken out, dried in the kiln, and crushed and ground in the manner above described. Fat is a similar hindrance to drying the raw material. When guano, therefore, is to be produced from herrings, or flesh of whales, Greenland sharks, &c., the mode of manufacture is the same as in the case of salt fish, the fat being extracted by means of steam pressure, after which the mass is easily dried and ground. Guano of herring heads is manufactured in the same way as cod offal, the raw material being simply dried and ground; but this guano is of an inferior quality. As the quality of this manufacture depends very much upon the kiln, great attention is always paid to see that it is a thoroughly good one, as when the mass is well dried, the crushing and grinding is more easily and perfectly effected; if, on the other hand, the kiln is not a good one, it will cake together when ground, and yield a rough and fibrous product. All the Norwegian manufactories are situated in Lofoden and Finmark, where the raw material can be procured cheaply and abundantly, and where the first drying process is easily effected in the peculiarly dry air of the northern regions. The consumption of cods' heads for the manufacture of guano is, on the average, about 16,000,000 per annum. Consul Crowe states there is reason to believe that the utilisation of the offal from the fisheries will be carried on to a much greater extent than hitherto, a Swedish engineer, M. Sahlström, having recently made some very important discoveries in this branch of industry. Among the articles to be produced, the inventor first mentions albumen, which is to be prepared from fish spawn. The annual yield of the latter amounts to about 50,000 barrels, which at the present value represents about £125,000, but if worked into albumen, the value would be at least £305,000.

Notes on Books.

GREEK AND ROMAN SCULPTURE: a Popular Introduction to the History of the Greek and Roman Sculpture. By Walter Copland Perry. London: Longmans, Green and Co. 1882. 8vo.

The author divides his subject into six periods, commencing with mythical art in Greece, and ending with the Græco-Roman period. The works of the chief artists, as Pythagoras, Myron and Calamis (the forerunners of Pheidias), Pheidias himself, his pupils, Polycleitus, Scopas of Paros, Praxiteles, Pasiteles, and the schools of these great artists, are all discussed in their chronological order. The last two chapters are specially devoted to the subject of portrait sculpture, in which the chief statutes and busts of the celebrated Greeks and Romans, of Roman women, of deified emperors, and deified women, are described. The principal objects which the author had in view in producing this book are stated by him to be (1) to supply the first step to the student of the subject; (2) to set before the artist the principles which guided the greatest masters during the grandest period of art; (3) to furnish the inexperienced amateur with the knowledge requisite to enable him to understand and appreciate the remains of ancient art in our museums; (4) to direct special attention to the relation between Greek art, and the religious, political, and social life of the Greek people. The volume is very fully illustrated with woodcuts of some of the most important remains of ancient sculptural art.

LESSONS ON FORM, for the Use of Teachers and Pupils in Elementary Schools. By Richard P. Wright. London: Longmans, Green and Co. 1882.

The principles taught in this elementary treatise are founded upon Pestalozzi's system of teaching geometry, which has long been practised in Holland, Switzerland, and Germany; and the author hopes that the lessons will "be suggestive to teachers of those amplifications which beginners always need in an abstract subject like geometry."

OFFICIAL RECORD OF THE SYDNEY INTERNATIONAL EXHIBITION. Sydney, 1881. London: Trübner and Co.

The Sydney Exhibition was opened on September 17th, 1879, and closed on April 20th, 1880, during which period 1,117,536 persons were admitted. The money received from the sale of tickets of admission amounted to £40,432 9s. 6d., being the net balance after deducting commissions on sales. A comparative table of attendances at the chief International Exhibitions is here given, from which the following figures are taken:—

London	1851	6,170,000
Paris	1855	4,533,464
London	1862	6,211,103
Paris	1867	9,300,000
Vienna	1873	7,254,867
Philadelphia	1876	10,164,489
Paris	1878	16,032,725
Sydney	1879	1,117,536
Melbourne	1880	1,309,496

The number of awards made by the judges at the Sydney Exhibition was 7,554. The Department of Awards cost £21,000, independently of £40,000 paid to the judges, and it took over two years to complete the work of issuing the diplomas and medals. This record contains a general report, and the reports of the judges, the whole being completed by a full index.

THE HERRING AND THE HERRING FISHERY, with chapters on Fishes and Fishing, and our Sea Fisheries in the future. London: Hamilton, Adams and Co., 1881.

This little book contains some account of the herring, with a history of the herring fishery, and its connection with Great Yarmouth. In the last chapter reasons are given for disapproving of the present laws on the subject; and the Shipping Act of 1880, and the appointment of Fishery Commissioners are specially considered.

THROUGH SIBERIA. By Henry Lansdell. London: Sampson Low, Marston, Searle, and Rivington. 1882. 2 vols., 8vo.

On the occasion of the reading of Mr. Henry Seebohm's paper on "Trade and Commerce with Siberia, *viâ* the Kara Sea," before the Society of Arts, on February 4th, 1880, the Rev. Mr. Lansdell made some remarks on the opening there was for trade and commerce on the Amoor. He has since published a record of his journey through Siberia, which was undertaken chiefly for the purpose of observing the condition of the prisons. In this the author gives an account of his visits to the different mines, but he tells us that he sought in vain for any quicksilver mines, and therefore asserts "that there does not exist a quicksilver mine in Siberia at all." He notices the voyages of Nordenskjold and Wiggins, and makes special mention of the commercial value of the basin of the Obi, and a large part of Western Siberia, if advantage were taken of their capabilities. It is the opinion of both Professor Nordenskjold and Captain Wiggins, that "a regular sea communication between Siberia and Northern Europe during a short season of the year, ought not to be attended with greater risks and dangers than seamen encounter on many other waters now visited by thousands of vessels."

General Notes.

FIRES IN 1881.—From Captain Shaw's report of the Metropolitan Fire Brigade for 1881, it appears that the calls for fires were 2,376, as against 2,194 in the previous year, an increase of 182. The above figures include, however, 240 false alarms and 145 chimneys on fire, so that the actual fires were only 1,991. This number shows an increase upon the fires of 1880 of 120, and, compared with the average of the last 10 years, there was an increase of 351. During the year the serious fires were only 8 out of every 100, whereas a few years ago they were more than three times that number. A tabulated return furnished by Captain Shaw, shows that the proportion of serious fires in 1866 formed 25 per cent of the whole; in the following year it was 18, then 14, then 13, and in 1872, for some unexplained reason, the percentage was only 8 of the whole. Next year it was 11, and then fluctuated from 10 to 11 in subsequent years, till last year it was only 8. That is to say, out of the 1,991 fires, only 167 were serious. The fire-engines of the 53 land stations ran, in pursuit of fires, 62,904 miles, on 28,441 separate occasions. These figures are in excess of the previous year, when the number of journeys was only 25,754, and the miles run only 58,377. The quantity of water used was considerably less—namely, 17,232,682 gallons, or about 76,391 tons, against 21,072,739 gallons, or 94,075 tons, in the previous year. About half of the water used, 36,669 tons, was taken from the river, canals, and docks, the remainder being obtained from street mains. As regards the water arrangements, there were 45 cases in which they were defective. In three instances the supply was short, in 33 the turncocks arrived late, and on 9 occasions the turncock did not come at all. With respect to the strength of the Brigade, there are now 536 men, including the chief officer, superintendents, and all ranks. This is an advance of 51 upon the previous year, and is the highest roll yet existing. During the night time, 243 men are on duty, and 105 by day, so that there are 348 employed in the several watches during every 24 hours. This is an increase of 39 upon the previous year. The remaining men are available, with the exception of those sick or absent, for work at fires. There are now 53 fire-engine stations, 11 as against 5 movable stations, and 4 floating stations. and there are 153 against 148 land and 3 floating engines, as well as 121 escape stations, where 137 machines and scaling ladders are kept. In connection with the several stations are 53 telegraph lines, 7 telephone lines; and, lastly, there are 7 fire-alarm eircuits, with 44 call points.

ROYAL SOCIETY OF NEW SOUTH WALES.—This society offers a prize for the best commnunication, containing the results of original research or observation, upon each of the following subjects:—Series I. (to be sent in not later than September 30th, 1882)—1. On the Aborigines of New South Wales, £25. 2. On the treatment of auriferous pyrites, £25. 3. On the forage plants indigenous to New South Wales, £25. 4. On the influence of the Australian climates and pastures upon the growth of wool, £25. Series II. (to be sent in not later than August 31st, 1883)—5. On the chemistry of the Australian gums and resins, £25. 6. On water supply in the interior of New South Wales, £25. 7. On the embryology and development of the marsupials, £25. 8. On the Infusoria peculiar to Australia, £25. The competition is not confined to members of the society, nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way; the communication to be successful must be either wholly or in part the result of original observation or research on the part of the contributor.

BLACKFRIARS-BRIDGE.—At a meeting of the Court of Common Council, Mr. Deputy Edmeston moved:—"That it be referred to the Bridge House Estates Committee to report to the Court as to the desirability of proceeding with a fresh competition for the four groups of statuary on Blackfriars-bridge, on the following basis:—That ten sculptors shall be invited to compete for these works, and that so many of these as may consent to do so, shall receive an honorarium of £200. That the general terms of the competition shall be first of all approved by Sir Frederick Leighton, President of the Royal Academy, Mr. Calder Marshall, R.A., and Mr. Watts, R.A., and that these gentlemen shall be requested to act as referees in the final decision. Mr. Deputy Rudkin (the chairman of the Bridge House Estates Committee) undertook that the suggestions should be considered by the committee, when the motion was withdrawn.

THE SOCIETE FRANCAISE D' HYGIENE.—The Société Française d' Hygiène, 30, Rue du Dragon, Paris, offers gold, silver, and bronze medals for essays on (1) the hygiene and physical education of children during the second period, from 6 to 12 years of age, in the house, the school, the field, and the workshop; and (2) cleanliness of the house and person at different ages, and under different social conditions, both in town and country. Manuscripts are to be sent in anonymously before the 1st September.

STATE OF THE THAMES.—At a late meeting of the Court of Common Council, a report was presented by the Port of London Sanitary Committee on the reference of the 6th October, 1881, to inquire into the sanitary condition of the River Thames in the neighbourhood of Crossness and other outfalls, and to report what steps should be taken to remedy any existing evils thereat, with authority to confer with her Majesty's Government thereon, and recommending that application be made to the Home Secretary to take action under the provisions of the 21st and 22nd Vic., cap. 104, sec. 31. The report was adopted.

PATENT BILL. — The following resolution was passed on Monday evening, 6th inst., at a meeting of the Cleveland Institution of Engineers, Middlesborough, after the reading of a paper by Mr. J. Head, on "The Society of Arts' Bill for the Amendment of the Patent-law":—"That this meeting of the Cleveland Institute of Engineers desires to record its general approval of the Society of Arts' proposed Bill for the amendment of the Patent-law; that it considers the same a substantial improvement upon the existing law; and requests the Council to take such action as may appear advisable to give effect to this resolution."

SILKWORMS.—Mr. W. Martin Wood writes to correct an error in the report of his remarks on Mr. Cochran's paper, which appeared in the last number of the *Journal* (p. 290). Mr. Wood's statement about the new variety of silkworm moth produced in India, was to the effect that it was a cross between the Yamamai, an oak-feeding silkworm of Japan, and the Tussah moth of the Indian jungles. The hybrid worm will feed on trees other than the mulberry, not only on the *Zizyphus jujuba*, as does the Indian worm, but on almost any of the *Ficus* variety everywhere diffused throughout India.

THE ST. GOTHARD TUNNEL.—The St. Gothard Tunnel has been opened, and a regular train service has been established between Airolo and Goeschenen. Unfortunately the lines connecting Airolo and Goeschenen with Bellinzona and Fluelen, and the section from Olten to Zug, are not yet completed, so that the journey has still to be accomplished in part by road, and the saving in time and fatigue is but little. The trip from Basle to Milan occupies about 22 hours, the whole distance being less than 200 miles. The new route, therefore, is not likely to compete successfully with that by the Mount Cenis, and until it does this, expected acceleration of the service from Paris to Turin will not be made. It is, however, stated that before the end of the spring the missing links on the Swiss route will be completed, and Italy will then reap the benefit of being connected with the north-west of Europe by two competing and wholly independent lines. Passengers from Paris will, therefore, before next year save six or eight hours, that are at present unnecessarily wasted between Paris and Modane, while those who come from London by Germany and Switzerland may hope to do the journey from London to Rome in 42 hours instead of 52 as at present. The chief gain by the opening of the new through line will be Genoa, which now must have the sea-front of Switzerland and the south-west provinces of Germany. The raw material for the cotton manufactures of Switzerland has hitherto been imported by way of Havre or Antwerp, or from Trieste or Venice, by the roundabout Bremen route. In proportion as Genoa will be a gainer, the merchants of Trieste will be losers, and a petition has already been presented by them for obtaining a Government subvention for a new line to put Trieste in more direct communication with Switzerland and the west.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 15.—"The Art of Turning." By P. N. HASLUCK.

FEBRUARY 22.—"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON.

MARCH 1.—"The Teaching of Forestry." By Colonel G. F. PEARSON. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., will preside.

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S.

MARCH 15.—"Gas for Lighthouses." (Illustrated by an Exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM.

MARCH 22.—"Telephonic Communication." By LIEUT.-COL. C. E. WEBBER.

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 28.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Practical Science of Moscow.

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

FEBRUARY 23.—"Photometric Standards." By HAROLD DIXON. Dr. A. W. WILLIAMSON, F.R.S., will preside.

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

FEBRUARY 17.—"The Depreciation of Silver as it affects India." By J. M. MACLEAN. A. J. BALFOUR, M.P., will preside.

March 17.—"Village Life, and the Village System in the Bombay Presidency." By W. G. Pedder.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Second Course is on "Recent Advances in Photography." By Captain Abney, R.E. F.R.S.

Lecture 3, February 13.—Dry plate processes, Instantaneous pictures. Instantaneous shutters. Enlargements, direct and otherwise produced. Colour of developed prints. Applications of photography to science.

Lecture 4, February 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Capt. W. de W. Abney, "Recent Advances in Photography." (Lecture III.)

Institute of Surveyors, 12, Great George-street, S.W. 8 p.m. Discussion on Mr. J. L. Pattisson's paper, "Fair Rent."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Sir Richard Temple, Bart., "Geography of the Birth-place and Cradle of the Mahratta Power in Western India."

London and Middlesex Archæological, 4, St. Martin's-place, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. J. Byron, "The Border-line between Farce and Comedy."

Chemical Industry, Burlington-house, W., 7½ p.m. 1. Mr. C. T. Kingzett, "Waste Products and Undeveloped Processes." 2. Mr. J. Spiller, "A New Source of Potash Alum."

Tuesday, Feb. 14...Royal Institution, Albemarle-street, W 3 p.m. Professor J. G. McKendrick, "The Mechanism of the Senses." (Lecture V.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Joseph James Coleman, "Air-Refrigerating Machinery and its Applications."

Photographic, 5a, Pall-mall East, S.W., 8 p.m. Annual Meeting,

Royal Colonial, The Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Lieut-Colonel T. Hunter Grant, "The Progress of Canada and the Development of the Great North-West."

Wednesday, Feb. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. P. N. Hasluck, "The Art of Turning."

Meteorological, 25, Great George-street, S.W., 7 p.m. Mr. C. E. Burton and Mr. R. H. Curtis, "Notes on Experiments on the Distribution of Pressure upon Flat Surfaces perpendicularly exposed to the Wind." 2. Commander R. A. Edwin, "The Principle of New Zealand Weather Forecasts." 3. The electrical thermometer, lent by Messrs. Siemens Bros., for observing the temperature of the air at Boston Church tower, will also be exhibited.

Public Analysts, Burlington-house, W., 8 p.m. 1. Discussion on the Water Valuation Scale. 2. Mr. W. Johnstone, "Some Analyses of Milk which have fallen below the Society's Limit." 3. Mr. H. Leffman, "Notes of some Experiments on the Action of Organic Matter on Silver Salts."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. Dr. Phené, "Recent Researches and Excavations in Scotland."

Institute of Bankers, London Institution Theatre, Finsbury-circus, 7 p.m. Mr. M. D. Chalmers, "Notes on the Bills of Exchange Bill, 1881."

Sanitary Institute of Great Britain, 9, Conduit-street, W., 7¾ p.m. Mr. Henry C. Burdett, "The Administration and Hygiene of British Hospitals."

Thursday, Feb. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Exhibition of Photographic Appliances and Demonstration of Photography by Artificial Light.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. Stephen Wilson, "Potato Disease and the Theory of Fungoid Parasitism." 2. Lieut. J. F. Cockburn, "The Shells of Aden."

Chemical, Burlington-house, W., 8 p.m. 1. W. H. Perkin, "On the Luminous Combustion of Ether at Temperatures Below Redness." 2. Dr. Flight, I., "Contributions to our Knowledge of the Composition of Alloys, for the most part Ancient;" II., "The Preparation of Pure Nitrogen, and on the Action of Nitrogen and Hydrogen on Meteoric Silicates;" III., "The Action of Sodium Carbonate and Hydrate on Felspars and Wollastonite." 3. Mr. E. H. Rennie, "Benzyl-phenol;" (part II.) 4. Mr. J. C. Thresh, "The Buxton Thermal Waters. 5. Mr. F. J. Lloyd, "Retrograde Phosphates." 6. Mr. Percy Smith, "The Dissociation of Chlorine."

London Institution, Finsbury-circus, E.C., 7 p.m. Professor H. E. Armstrong, "The Economical Use of Coal Gas for Lighting and Heating."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. L. Sclater, "The Geographical Distribution of Animals." (Lecture I.)

Royal Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. M. A. Pollard Urquhart, "Water Fittings."

Friday, Feb. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. J. M. Maclean, "The Depreciation of Silver as it Affects India."

Geological, Burlington-house, W., 1 p.m. Annual Meeting.

Royal United Service Inst., Whitehall-yard, 3 p.m. Colonel W. W. Knollys, "The French Autumn Manœuvres of 1881."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Professor McKendrick, "The Breathing of Fishes."

Philological, University College, W.C., 8 p.m. 1. Mr. C. B. Cayley, "The Distribution of the Accent in Greek Words, with Notes on Pronunciation." 2. Mr. B. Dawson, "Notes on the Revised and other Versions of the Bible."

Saturday, Feb. 18....Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Watkiss Lloyd, "The Iliad and Odyssey." (Lecture I.)

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FRIDAY, FEBRUARY 17, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third lecture on "Recent Advances in Photography" was delivered by Captain W. de W. Abney, R.E., on Monday, 13th instant. The lecture was devoted to the consideration of dry plate processes. The rapidity of a gelatine emulsion was shown by taking a photograph of a rapidly rotating disc by the spark from a battery of Leyden jars, while the sensitiveness of an emulsion of silver bromide in a certain molecular condition was illustrated by photographing the carbon points of the electric arc through a sheet of solid ebonite. The process of enlarging on paper coated with gelatino-bromide and gelatino-chloride emulsions was briefly shown, and the new gelatine films, invented by Mr. Warnerke, for the purpose of superseding glass for negatives, were shown, as well as the application of such films to the reproduction of prints in different colours.

The lectures will be printed in the *Journal* during the summer recess.

PHOTOGRAPHIC EXHIBITION.

The Exhibition of Photographic Appliances will be kept open till February 25th, every day from ten to four, and on Wednesday evening from six to ten. On Monday evening the Exhibition will be open to those attending the fourth and last of Captain Abney's Cantor Lectures.

Persons not members of the Society, who are interested in Photography, may obtain tickets on application to the Secretary.

A demonstration of Photography with artificial lights was given on Thursday, 16th inst. A notice of this meeting will be given in next week's *Journal.*

It is probable that the evening of Monday, the 27th, will be devoted to illustrations of some of the more recent methods of photographic printing, but as the arrangements are not complete, a definite announcement cannot be made at present. Full particulars will be given in next week's *Journal.*

Proceedings of the Society.

ELEVENTH ORDINARY MEETING.

Wednesday, February 15th, 1882; Thomas Wm. Boord, M.P., F.S.A., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Akester, William Hopkin, 111, Great Western-road, Glasgow.
Bayley, Edmond Kelly, 2, Lancaster-street, Hyde-park, W., and 11, King's Bench-walk, E.C.
Canning, Thomas, The Retreat, Clytha-park, Newport, Monmouthshire.
Cockran, William, Overdale, Dunblane, Perthshire.
Coote, Capt. Frederick, 34, Newington-green, Stoke Newington, N.
Denniss, William John, 344, Wandsworth-road, S.W.
Heisch, Charles, F.C.S., F.I.C., Holly-lodge, South Park Hill-road, Croydon.
Howard, John, F.C.S., Islington School of Science and Art, Windsor-street, Essex-road, N.
Hummel, J. J., The Yorkshire College, Leeds.
Malan, Ernest de M., District Railway Works, West Brompton, S.W.
Scott, James, Universal Electric Company, Limited, Baltic Works, Bridgeton, Glasgow.
Varley, Frederick Henry, Mildmay-park Works, Highbury, N.
Wrigley, Percy T., B.A., 23, Sydney-street, South Kensington, S.W.

The following Candidates were balloted for and duly elected Members of the Society:—

Berens, Alexander A., 68, Great Cumberland-place, Hyde-park, W.
Brightman, Edward, Lyndale, Redland-road, Bristol.
Christie, Alexander Livingston, M.B., H.M. ship *Excellent*, Portsmouth.
Dymond, Edward E., F.M.S., Oaklands, Aspley Guise, Woburn.
Oliver, William Robert, 40, Chancery-lane, W.C.
Radcliffe, Arthur H. W., Addison-villa, Water Orton, near Birmingham.
Rolls, Arthur Frederick, Holmlea, Sutton, Surrey.
Schwabe, Frederick Salis, Rhodes, Middleton, Manchester.
Viles, Edward, Codsall Wood, near Wolverhampton.
Wilson, Robert, 24, Poultry, E.C.

The paper read was—

THE ART OF TURNING.

By Paul N. Hasluck.

A definite idea of the subject matter of this paper is desirable before an attempt is made to enlarge upon it. Speaking broadly, the art of turning consists of shaping articles on a lathe. To define the art more closely, we understand it to mean the fashioning of articles that are themselves revolved on the lathe, and which are acted upon by a cutting tool held by the hand, or in a slide rest.

The process of shaping materials by means of rapidly rotating cutters, often practised on the lathe, should not be considered as turning. I refer especially to the work produced on machines conventionally called "lathes for turning irregular forms," and used for making boot-lasts, gun-stocks, and many other articles. Within the last few years, these machines have been greatly improved, and have, in fact, completely revolutionised certain branches of the wood-working trades.

In plain turning, the work rotates on the line of centre, and the contour formed by the cutting tool must necessarily be circular. By means of elaborate chucks, the work may be made to travel in various directions simultaneously, and in this way geometrical figures are traced by a fixed tool. Ovals are turned by simply moving the work to and fro, at right angles to its axis of rotation, by a synchronous motion. An inclined plate on the mandrel, working against a fixed roller, and giving the mandrel a motion lengthwise whilst it is rotating, affords the means of producing oblique mouldings, well-known as "swash-plate" turning.

For turning very large diameters, especially when the objects are heavy, lathes are frequently vertical; that is, the mandrel is upright, and the face-plate, always fixed to it, revolves horizontally. It is much easier to chuck work on the face-plate in that position. The largest lathe, having the mandrel in the usual horizontal position, that I know of is capable of turning a disc twenty-five feet in diameter. It weighs about sixty tons. A vertical lathe, that is one having the mandrel upright, in use in one of the American Dock-yards, is constructed to take an entire monitor turret, and rotate it whilst turning tools are brought to act upon it.

In the Arsenal at Woolwich, a larger lathe, very similar in construction, is in use. It is called a circular planing machine, but I should like to know for what reason? It appears that a lathe may have its line of centres either horizontal or vertical, or at any inclination. With the machine at Woolwich, the work is itself revolved; a tool is held in a slide rest—in fact there are two distinct tool holders at diametrically opposite points. Why is the machine not called a lathe, and the work produced upon it turnery? So far as our original definition of the art serves us, that machine is a lathe, though some may cavil at the designation. The lathes erected at Woolwich for turning the large guns, are amongst the largest and heaviest constructed; they weigh over 84 tons each.

Having now some definite ideas of what the art of turning really is, the subject may be profitably studied in its various branches.

Turning indisputably holds a forward place in the useful arts, and it is one of the oldest. The lathe has been aptly called the "father of mechanism," so much is mechanism indebted to it for its very existence. The date of the origin of the art is lost in antiquity. It was probably known before historians began to write. The potter's wheel is believed to have been the earliest form of lathe. This primitive lathe is now commonly used by the potters of the present day; it is, technically, "a throw." The oldest Egyptian monuments had representations of the potter at work with his lathe. This takes us back two thousand years before the Christian era. Ptah, a god worshipped as the leader of mundane artisans by the Memphites, who flourished about two thousand years before Christ, is represented in the act of moulding man upon a potter's throw. Thus we find in the earliest records a special tribute to the art of turning, which, in that remote period, was evidently deemed the art by which man was fashioned. In Scripture history we have in Jeremiah a distinct allusion to the potter and his wheel. This date is about 500 years B.C.

The Rev. W. M. Thomson, who was for 25 years a missionary in Syria and Palestine, gives an excellent illustration of a modern potter at work. It will be found in his work entitled "The Land and the Book," published in 1859. The description is given thus:—"I have visited the potteries, and was delighted to find the whole Biblical apparatus complete and in full operation. There was the potter sitting at his frame, and turning the wheel with his foot. He had a heap of the prepared clay near him, and a pan of water by his side.

Taking a lump of clay in his hand, he placed it on the top of the wheel (which revolves horizontally) and smoothed it into a low cone, like the upper end of a sugar-loaf; then thrusting his thumb into the top of it, he opened a hole down through the centre, and this he constantly widened by pressing the edges of the revolving cone between his hands. As it enlarged and became thinner, he gave it whatever shape he pleased, with the utmost ease and expedition. From some defect in the clay, or because he had taken too little, the potter suddenly changed his mind, crushed his growing jar instantly into a shapeless mass of mud, and, beginning anew, fashioned it into a totally different vessel."

The processes employed by the Hebrews were probably similar to the Egyptians, from whom they had learned the art. The wheel used consisted of a wooden disc placed on another larger one, and turned by hand by an attendant, or worked by foot by the potter himself.

Sir Gardner Wilkinson, in his book, "The Manners and Customs of the Ancient Egyptians," published in 1836, says:—"Potters are represented in the tombs of Thebes and Beni Hassen. They frequently kneaded the clay with their feet, and after it had been properly worked up, they formed it into a mass of convenient size with the hand, and placed it on the wheel, which to judge from that represented in the paintings, was of very simple construction, and turned with the hand." The author, in continuation, says:—"It is impossible to fix the period of the invention of the potter's wheel, but it was known at the earliest epoch of Egyptian history, of which the sculptures have been preserved. The notion that the gods imparted to men the arts of civilisation was common to the Egyptians as to the Greeks, and Neph is represented showing them the potters' art.

Geologists have discovered pottery ware in some of the oldest formations which contain human remains, but this pottery was, it is evident, made by hand-moulding, and not by being thrown or turned upon a wheel.

The turning lathe of modern form was apparently not known in those early times. Though many trades and occupations are vividly represented upon the sculptured records of ancient Egyptians, the turner—other than he working at the potter's wheel—is unrepresented. This fact leads to the conclusion that the turning lathe proper was unknown in Egypt.

Turning was evidently one of the arts practised by the Greeks and Romans. Their writers mention lathes and turners frequently some five hundred years before the Christian era.

Diodorus Siculus says the inventor of the art of turning was a nephew of Dædalus, named Talus; the reputation he acquired by this invention excited the jealousy of Dædalus, who put Talus to death secretly. If this account is true, we have the name of an early martyr to the art. Pliny ascribes the invention to Theodorus of Samos, and also mentions one Thericles, who rendered himself very famous by his dexterity in managing the lathe. It was a proverb amongst the ancients to say a thing was formed on the lathe to express its delicacy and accuracy. Amongst the polite French people a precisely similar expression is used to-day to convey a high compliment.

The early practice of turnery was confined to fashioning wood. We read of bowls, also of flutes, and musical instruments that have been produced by the skilful turner. The application of the art to fashioning metal is of comparatively recent origin.

An attempt to trace the progress of the art of turning through successive generations would probably become wearying. The subject is a very speculative one. There are few indisputable data on which a connected history could be wrought. No treatise on the subject exists, and hence the difficulty in dealing with it.

Long before the fly-wheel, worked by a crank, was invented or used, lathes were driven with the aid of a spring pole, and also by bows; not used in the manner of the modern drill bow. The pole lathe is still in use in some trades—amongst which that of the watch-case maker occurs to me—but the alternating motion has been almost entirely superseded by the continuous fly-wheel. Pole lathes are drawn by the foot; an elastic springy pole is fixed by one end—usually to the ceiling—so that the free end is in a direct line with the mandrel pulley. A cord from the free end of the pole is passed around the pulley, and attached to the treadle. When the foot is applied, the mandrel is made to revolve in the direction necessary for cutting; on relieving the treadle of pressure, the elastic force of the spring pole draws the cord back, at the same time causing the work to revolve backwards. In this way the treadle is brought to its original position, ready for another effective stroke.

It is evident that this alternating motion is by no means economical. Every effective movement of the work is only the precedent of an equal amount of non-effective motion. To take the matter at its best, and allow that the speed is in both instances equal, half the time employed in turning is wasted in waiting for the backward motion. Despite this obvious and serious drawback, the pole-lathe has been used ever since the invention of the centre lathe. In its earliest form this lathe consisted of two fixed centre points; between these the work was mounted. The cord was placed around the work itself, and no mandrel was used. Bergeron, in his book on turning, published in 1792, illustrates and describes lathes of this description as being machines of the period. At the present time watch-case makers use them, the alternating motion being convenient. When the watch case is partially finished, and has the knuckle, or the pendant, soldered on, it may be mounted on the old-fashioned pole lathe, and, by deterously regulating the amount of the motion given to the treadle, the work is revolved barely a complete turn, and thus the whole edge of the case, excepting the one projecting piece, may be operated upon by the tool. In the modern lathe this operation would be impossible; when the circular motion is continuous, the projections cannot be left intact. This explanation accounts for the apparent inconsistency of using a pole lathe in the present perfected state of the art of turning, in a country where its development is perhaps the most complete.

Native turners of Africa and India still practice their art with the primitive pole lathe. A somewhat similar tool, worked with a drill-bow, is used by the Arabs and Persians.

The derivation of the word "lathe" has been attributed to the pole used for working the earliest turning machines. The pole, in order to render it fit for use, was pared down to a taper form, and thus made to resemble a lath. The English word lathe is one that has been specially bestowed by us. "Turn," is the word applied, in other languages, to the machine. We yet call the smallest form of lathe, in common use amongst watch-makers, "turns."

A German book, published in 1568, shows a turner working a sphere in a lathe. The illustration makes the construction of the machine tolerably clear. It is the first record of a lathe mounted on standards. The pole is used, and the cord is passed around the work itself. This shows that the mandrel was not then employed. Different kinds of lathes are mentioned in works of about the same period, but the centre lathe appears to have been the only one known. The introduction of the mandrel, itself running in bearings, is not defined. All the work lying around the turner of 1568 is of wood; and, in fact, the working of metals on the lathe is comparatively only a recent introduction.

A French mathematician and inventor, named Jaques Besson, who flourished about the third quarter of the sixteenth century, illustrated, in a book published in 1579, three different forms of lathes, in which the pole, an ordinary bow, and weights were respectively employed to produce the return motion of the cord when the pressure was taken from the treadle, after an effective stroke had been made with the foot. One of the lathes invented by Besson was capable of cutting screws of any pitch, by the employment of pulleys and band gearing. Right or left-handed threads could be cut at will, by crossing or uncrossing the band, and the pitch was regulated by means of pulleys of different diameters. This is the earliest screw-lathe known.

Joseph Moxon, an Englishman, hydrographer to King Charles II., gives the first known intelligible description of a metal turning lathe, in a small book entitled "Mechanick Exercises," which was brought out in monthly parts, commencing in 1677. In this, the art of turning occupies a large proportion of the space. It will be interesting to quote the quaint language used in this book. The description accompanies an illustration of a turn-bench held in a bench-vice. The work is rotated by means of a drill-bow, and a sphere is shown being turned. The chapter reads as follows:—

"Of Turning small work of brass or other mettal. Small work in mettal is turned in an Iron lathe called a turn bench. The figure of it is described in plate sixteen at C. When they use it they screw it in the chops of a vice, and having fitted their work upon a small iron axis, with a drill-barrel fitted upon a square shank at the end of the axis next the left hand, they with a Drill-bow and Drill string, carry it about as was shewn in smithing, with this difference that when a hole is drill'd in a piece of Mettal they hold the Drill-bow in their Right Hand; but when they Turn small work they hold the Drill-bow in their left Hand, and with their Right Hand grasp the Tool, which is commonly a Graver, or sometimes a Sculpter, fit to such Moldings as are to be made on the Mettal. They begin to work first with the sharp point of a Graver, laying the Blade of it firm upon the Rest, and directing the point to the Work, and lay Circles upon it close to one another, till they have wrought it pretty true. Then with one of the broad Edges of the Graver, they Smoothen down what the Point left, and afterwards with Sculpters, Round or Flat, or great or small, they work their intended Mouldings. The circumstances and considerations in the choice of a Drill-bow and Drill-string for Turnery are the same with what you find in Smithing and Drilling."

That the art comprehended the fashioning of metal at a remote period, evidence exists. Metal vessels, exhumed from the ruins of Thebes, bear unmistakable marks of the tool applied when the object was rotating. The machinery then in use, probably lacked the stability necessary for turning metal successfully.

Various forms of fly-wheels are shown in books published about the beginning of the nineteenth century, proving that the continuous rotary motion was then used. The pole was, however, evidently preferred, and now soft wood turners use it. The alternating motion allows them some advantages, which we need not here discuss.

The fly-wheel, driven by hand, is still in use by turners, where labour is cheap. The small motors which are now made, and which are rapidly increasing in public favour, will probably supersede manual power within a short space of time. The hand-driven fly-wheel offers the advantage of leaving the turner unfettered by any work, except that of manipulating his tools. The fatigue of working the lathe is spared him, and he can give his undivided attention to the work on which he is engaged. More power can be got from a man whose energy is confined to turning a winch-handle than from he who works a treadle with one foot; hence the hand-wheel gives the turner greater power.

Steam-power is now generally used in our manufactories, and it has become the means of driving by far the largest portion of lathes used in various industries. The cheapness of the power is its chief recommendation, and the one that at once commends it to the manufacturers. For many operations the foot lathe is still more advantageous; the complete control that the turner possesses over the machine that he drives with his own muscles is a boon that is essential when treating delicate work. The various speeds requisite for various operations are regulated intuitively by the man who works his own lathe. On the other hand, steam-power applied to a lathe, for doing work of one particular calibre, and which is also fitted with automatic gearing, does all the work. When the machine has been set to work, it will continue to work till the automatic arrangements stop it at the end. An occasional overlook from the mechanic is all that is needed, till the work in the lathe is changed for some other.

The automatic lathes now in use for producing large numbers of objects, each of which are counterparts, are attended by mere lads, who have only to turn a handle or shift a lever, as occasion requires, in order to keep the machine at constant work. Every object made by these automatic lathes is precisely alike. The machinery makes no error of judgment; everything is turned to gauge, as predetermined; and when an accurate machine is used, the work produced by it is accurate.

The relative value of machine work, as compared to hand work, is readily appreciated by every mechanic. A plain cylindrical rod—say, for instance, a bar of shafting—may be mounted on a self-acting lathe, and turned up perfectly true, parallel, and smooth. Suppose the same operation had to be done with hand tools. Compare the truth, the parallelism, and the smoothness of the two bars. In each case the comparison would be favourable to the machine-work. Then consider the time taken for each operation, and thus arrive at the comparative cost. The labour—that is to say, the skilled labour—in the first case is an unnecessary quantity; whereas, in the second case, only a turner of exemplary skill could do the work. Compare the relative wages of the artificers, and the amount of work that each produces, then you can appreciate the value of machine-work.

Having made a digression from my attempt to trace the history of lathes, I will now briefly resume that subject.

Independent mandrels were used about three hundred years ago; one is figured in a book dated 1568. The idea of employing a mandrel on which the work could be fixed, probably suggested itself from the use of a contrivance precisely analogous to our modern collar-plate. A contrivance of this kind was used long ago, as we use it now, for boring objects rotated in the lathe. Centre lathes—that is, those with fixed centres, which we now call dead centres—were used by the past generation of wood-turners. Mandrels were known and described by the French writers about two hundred years ago, but they do not appear to have been much used. The machinery for making a good headstock did not exist at that time, and the requirements of the age did not exact the high-class turnery of the present time. The perfection of turnery was gradual, as in other arts. So long as bedposts and common furniture were all that was wanted from the turner, we may well understand that he was content to use the lathe as I have described it.

The state of the mechanical arts in the early days of the eighteenth century is shown by Plumier's instructions how to cut screws on the mandrel which shall be tolerably true. As a superior method, he recommends that an angular slip of paper is to be coiled around, and then cemented upon the mandrel. The margin of the paper forming a spiral line, is to be carefully followed with a knife, which would cut through the paper, and mark a thread upon the mandrel beneath. This line served as a guide for filing a groove, which was enlarged to form a screw thread. This method of originating screws was employed even so recently as the beginning of the present century. If all this process was necessary in order to cut a screw thread, we may easily understand why mandrels were, to an extent, forbidden.

Wood was used to construct lathe heads, and the wood was fastened together by wedging. Besson's idea of cutting screws by band-gearing was apparently not acted upon. Mandrels had guide screws cut upon them, and were traversing mandrels, which had a longitudinal motion, equivalent to the pitch of the guide screw which was in use. The wooden headstocks were all more or less subject to distortion from atmospheric changes, and from this cause uniform accuracy was not to be depended upon.

The employment of cast-iron as a constructive material for lathes at once gave a great impetus to the art of turning. Iron headstocks, giving greater steadiness, were quickly used to produce better work. Iron beds followed, then slide rests were invented. The requirements of the age created a market for mechanism, and to supply this the lathe and its appliances were perfected to cope with the work in demand.

Slide rests were but rude contrivances till the planing machine was applied to shaping metal. Wood planing machines had been in use some years before the same principle was applied to metal working. In the "Philosophical Transactions" for 1747, the art of casting articles of iron is spoken of as a curiosity. The middle of the eighteenth century gives the date of the introduction of the steam-engine. In the production of this new engine the most advanced mechanical arts were requisitioned. The early mechanism was very imperfect; good substantial metal turning lathes were not then constructed; the planing machine for metal was not invented. The mechanic of the present day may appreciate the difficulties that his ancestors experienced only a generation ago.

It is now just fifty years since Joseph Clement communicated to the Society of Arts a description of his metal planing machine. This is probably the first machine of the kind. Bramah, who was the employer of Clement, used a kind of milling machine for shaping metal, and Clement made a planing machine specially for planing the triangular bars then used as lathe beds. Clement's planer is described and illustrated in the Transactions of the Society of Arts for 1832 (vol. 49). As a special tribute to the art of turning, the words of the inventor are particularly appropriate. He said he aimed to do with his planing machine for straight surfaces all that the lathe was made to do for round surfaces. That planing machine is, in its essential particulars, the same as the one now used. That Clement accomplished his aim is, therefore, a thing of the past.

Planed metal beds and accurate slides were a great feature in the improvement of turning-machinery. Sliding lathes, made before the planing-machine was used, were necessarily not only imperfect, but very costly. The utility of slide lathes was not, however, appreciated in their early days, and years passed before they were generally adopted. The necessities of the manufacture of modern wrought iron and steel ordnance, and the revolution they have caused in the construction of vessels of war, have called into requisition many new machines. New lathes, constructed on new principles, and adaptations to the older machines, have created quite new branches in the art of turning.

At the present time, materials of all kinds are wrought into shape on the lathe. The animal, mineral, and vegetable kingdoms, all furnish specimens on which the turner operates. All have claims on our attention for some peculiarity. The animal kingdom furnishes but a comparatively small number of specimens; but these are valuable and varied. Shells, bones, and horny substances—not forgetting ivory—are available for turnery. Mother-of-pearl—a term which includes a very large number of shells—is extensively wrought on the lathe. Buttons of this material are universally known, and though they are chiefly manufactured by means of annular saws, yet they claim a place amongst things made by the turner. Bone, either in its natural state, bleached, or dyed, furnishes the material for many objects of turnery. Horn, by its elasticity and toughness, and the facility with which it is worked on the lathe, serves the turner for an infinite variety of purposes. For screwing with fine threads, horn is, perhaps, the most easily manipulated substance. The natural veining of horn is itself beautiful, and the effect is further improved by tinting with various dyes.

Ivory is, of all materials, the one most in request by the ornamental turner. It is costly, beautiful, and most easy to turn. Its brilliant whiteness, fine grain, and great solidity are qualities that recommend it. It is easy to work and clean, so that its value to the amateur has no detractions, the high price and the limited dimensions perhaps excepted. Elephants' tusks furnish the greatest part of the ivory used in the arts, but other animals also furnish it.

The mineral kingdom furnishes the most useful and the most extensive assortment of specimens available for turning. Stones and marbles are wrought on the lathe with the best effect. Large columns of marble turned on the lathe are to be seen everywhere. The most minute work is also executed in stone on the lathe. Jewel-holes for watches, made of precious stones, are all turned. Apart from these, the mineral world furnishes all the metals, and in them we have an exhaustless supply of materials. Not only are the simple metals available, but the numberless alloys are, in many cases, equally so. It would be scarcely possible to enumerate the many and varied uses to which the turner's art has put metal. It is scarcely an exaggeration to say that every machine that is constructed owes the essentials of its being to the art of turning. The cylinder produced on the lathe finds employment in every kind of mechanism. The most powerful mill or engine, and the most delicate machine that the accuracy of modern science requires, each emanate from the lathe. The softest metal may be turned, and the hardest likewise, with almost equal facility, by means of a diamond tool. Steel, in its various forms, is probably the most largely wrought of all materials on the lathe; it also forms the majority of the tools with which the art of turning is practised.

The vegetable kingdom furnishes the various woods which are fashioned into innumerable objects—both useful and ornamental—by the turner. These specimens alone constitute an array of material as exhaustless as the metals. Each are applicable to their respective uses; each have their special claims for usefulness. An enumeration of all the woods would not, however, exhaust the list of vegetable material available for turnery. Betel-nuts, cocoa-nut-shells, and ivory-nuts, or vegetable ivory, are extensively used.

The materials available for working in this interesting art are therefore almost unlimited in their variety. Whether hard as ruby, or soft as plastic clay, heavy or light, malleable or brittle, these qualities recommend different materials. The speed at which turnery is executed varies as the substance turned. Soft wood may have a surface velocity of a mile a minute, and hard steel may run at a foot a minute. Intermediate speeds, according with different materials, are, of course, only natural.

The objects turned on a lathe vary in size, from a great gun weighing a hundred tons, to a watch balance staff weighing but a fraction of a grain. The machines used for the two purposes, show the two extremes in the sizes of modern lathes.

The extreme accuracy which is obtainable is strikingly exemplified in the manufacture of watches by machinery; the machinery being lathes. The essential exactness and agreement of the component parts of a fine specimen of a pocket timekeeper are proverbial. Until quite recently, every axis in a watch was turned by hand on the turn-bench; in this way each was a separate production. Skilled handwork was considered essential for the production of work of the necessary accuracy. Now, by means of an almost automatic lathe, the axes are turned each precisely like its fellow; and, indeed, so accurately are they, that they are interchangeable in the finished watch. This is an attainment that was doubtless considered impossible a generation ago. The Americans, however, perfected the necessary lathes for the work, and introduced machine-made watches, they having made clocks on the same principle previously. We have now in England some watch manufactories in which automatic lathes are extensively used, and some English watches are now made by machinery. To the lathe, its adaptation to the acquirements of the work, and to the perfection of the art of turning, must be attributed this astonishing revolution in the watch-making industries of this country.

Turnery, both the art itself and the objects produced, has been now so far perfected, that it seems difficult to limit the range of its application. The lathe is itself a production of a former lathe. As skill has increased, so have the productions of the lathe increased in perfection. The centre lathe gave the means of making the mandrel lathe; this produced the screw-cutting lathe, and so on through all the innumerable varieties of the tool now in everyday use. If lathes larger than the largest now used are wanted, they can be made on the machines now available. If mechanism is to be refined to a greater perfection than now exists, the tools to do it can be made on the lathes now in use.

DISCUSSION.

The SECRETARY drew attention to the many fine specimens of turnery lent for the occasion by several gentlemen, both amateurs and professional, and particularly to a splendid lathe exhibited by Mr. Evans, and a collection of tools. Amongst the specimens of turning, were those which had gained the prizes offered by the Turners' Company. As the paper was in the main an historical one, he might mention, that in reading Birch's "History of the Royal Society" lately, he found that in 1668, Captain Salter gave to the Royal Society "a specimen of the Queen's face turned with a turning lathe by a medal," and a note to the same page stated that "Dr. Fairfax wrote of this gentleman as being the greatest turner of the age, and that he had turned the King's picture, embossed as on the five pieces." He did not know what the five pieces referred to, but perhaps some antiquary could inform him. It seemed to him a very interesting fact, that this kind of work could be done at a time when the pole lathe was the chief implement in use, and when it was a question whether or not it was superior to the lathe with a continuous motion, which was just coming in. In the fourth volume of Mr. Holtzapffel's well-known book, he found that about the same period Moxon wrote a book on the lathe, in which he described a fly-wheel having a crank driven by a string. How they had at that time copying machines of such accuracy as to be able to turn a face, he must confess he did not understand; and if anyone present had any suggestion to make on the subject, it would be interesting. One other point he would mention for the consideration of gentlemen who practised geometric turning. In the Exhibition of Photographic apparatus, downstairs, might be seen some geometric patterns, traced on glass; and it might be interesting to state how these tracings might not only be produced, but reproduced with the greatest accuracy, to any number. This method was the invention of a friend of his, who was not only a skilful mechanician, but also a photographer, and by combining the two arts he had produced a most excellent result. He began by taking an ordinary piece of glass, a ¼-plate, as photographers called it, and then coated it with a thin film of collodion, with which was mixed a certain quantity of lac, a little aurine, a little of Judson's mauve dye, and a few drops of water; the formula was published in the photographic journals. This gave a film which was opaque to the actinic rays, and would produce a perfectly dense print. When dry, it was fixed in a chuck in the ordinary way, and could be drawn upon by a steel point fitted with a spring to prevent too great pressure, which might break the glass. It would be noticed on examining a specimen that, even where the lines crossed each other, the film did not chip or break away, but cut perfectly clean, however close the lines might be. He showed this to a member of one of the principal firms engaged on photographic printing processes, who told him they had long been endeavouring to find a film which would bear drawing on with a sharp point without breaking; he took a specimen away, and promised to make a printing block from it. When this transparency was obtained, you could print from it by any of the ordinary photographic printing processes; and as the film was so opaque to the actinic rays, it could be exposed until under the clear portions of the glass the prepared paper became absolutely black, while the parts protected by the film remained perfectly white, and thus you could get the blackest photographic print he had ever seen.

Mr. WILLIAM BOTLY said they must have all listened to the paper with great interest. As a young man, he took great pleasure in turning as an amusement; and could strongly recommend it for that purpose. He hoped this paper would prove a stimulus to many gentlemen to take up this beautiful art, which had many advantages over some of the frivolous amusements which were now in vogue. It might be practised very well in connection with wood carving, which had also lately come into favour.

Mr. HASLUCK drew attention to one of the drawings illustrating an old method of screw cutting, and said it must be a question, which some present would be able to discuss, whether it was possible to cut screws accurately by means of gut bands and semicircular grooves in pulleys.

Mr. SMYTHE thought the diagram referred to was rather too complicated to be readily understood by amateurs like himself. He should have been inclined to think that what the lecturer had pointed to as the guide, was really the work, and *vice versa.*

Mr. HASLUCK said the diagram was taken from a book 300 years old, and was somewhat obscure.

Mr. SMYTHE said he had seen in the last French Exhibition a modern lathe for turning short screws, with a guide screw on the end with a coarse thread, very much like the one there figured. It was not moved by pulleys and bands, however, which were apt to slip and spoil the screw, but by a cog-wheel, which he considered much better. A great many amateurs tried to turn short screws by bands and pulleys, when they would save much time by having one cog-wheel on the mandril and another on the slide-rest, or else a cog-wheel on the front of a large chuck, which would drive a wheel on the slide-rest.

Mr. BLASHFIELD said there was a marked difference between the throwing of pottery and turning, and the Greek vases of the highest class had all been turned after they were thrown. The practice was common in the potteries to chuck a thrown vessel in a lathe, and then the vessel was turned smooth. A great deal of work was now done also after the object was pressed vertically by merely placing a kind of screw in it vertically, and turning it by hand without any rest at all, A vast deal more work could be done than was at present, by providing proper tables, with a slow movement, for the hollow of the work turning first a piece to represent the inside of the work, and coating that piece with some material which would prevent another series of sheets of clay sticking to the first; then placing over that fresh clay, and turning that outside. It would be manifest that if clay was laid on a horizontal wheel, turned, and not allowed to dry, another bed of clay being over it, with a piece of paper between the two beds added, it would all shrink alike. If proper arrangements were made, pieces of large diameter, six or seven feet, might be turned without a rest on a horizontal table. He had himself experimented with success in this way.

The CHAIRMAN, in proposing a vote of thanks to Mr. Hasluck, said his only qualification for the position he had the honour of filling that evening was that he was a practical turner, and devoted most of his leisure time to the lathe. He was not altogether surprised that there was not much discussion, as the paper was, in the main, historical. Mr. Hasluck had described very clearly the history of the lathe from the earliest times, and drew attention to the wonderful development it had recently undergone; and, if they compared some of the drawings round the walls with the elaborate instrument which Mr. Evans exhibited, they must all admit that the art had wonderfully advanced. At the same time, he was not prepared to admit that the advance in recent times was quite so great as they were apt to think at first sight, because he remembered seeing on various occasions, both in England and abroad, examples of turning, especially of some examples of French turning of the time of Louis XIV., which were evidently executed with lathes of the most complex construction; in particular, some specimens of ivory turning of the kind known as swash-plate turning, of the most beautiful designs, which he thought it would puzzle modern turners to copy. He was much interested by Mr. Wood's reference to Captain Salter's invention, where he spoke of turning the Queen's face by a medal. That reminded him, very forcibly, of an invention which had been recently introduced, known as Lowe's Copying Machine, and in one of the cases was an example of a medallion copied by it. He could not help thinking, that the method described to the Royal Society in 1668 must have been very analogous to the action of the machine, but he could not understand what the inventor meant by saying he would undertake to turn faces by a good portrait. He need hardly say that he was an amateur in turning, and it might be asked what was the use of being an amateur turner. He could conceive there were many advantages in those whose occupations called them in another direction during the greater part of the day, devoting their attention to turning and similar pursuits of an evening, or in their leisure time. In the first place, many of the most notable inventions proceeded from amateurs, because an amateur was able to look at such work from an entirely fresh standpoint; he had not been brought up to the trade, and was not fettered by traditions and prejudices, for they must admit that prejudices did prevail amongst those who were occupied solely in one art. He was able to look on his amusement from a common sense point of view, and the result was, that in many cases valuable inventions were suggested, at any rate, by amateurs, even if they were completed by professional workmen. Again, there was another small matter deserving of attention, and that was the employment which amateur work of this description afforded young men. In this modern Babylon there were many facilities for spending time, not always in the most desirable way, and if there were a lathe and workshop at home, boys would often be induced to stay at home, when otherwise they would wander abroad. With respect to the old design of a screw-cutting lathe, he must admit that the method of cutting screws by means of bands was not altogether practicable, but there was an invention of the kind manufactured, he believed, by Messrs. Cooke, of York, which was not without its use. It was after all but a rough device, but it had this advantage, that you could cut any given screw by it, roughly. Again, in looking at the drawings, he was reminded of another device, which a friend of his often used for what ornamental turners called grailing. Before executing a geometrical or drilled pattern, it was usual to cover the surface of the work with fine concentric lines, which added greatly to its appearance. If on the grailed work you drilled a star, with a round pointed drill, you got a beautiful play of light. But this concentric grailing was a very tedious matter. You had to let the tool in for each circle, then move the slide-rest for each circle, and let it in again, and so on to the end of the story. This friend was foolish enough to undertake to turn a number of articles for a bazaar, and he thought the concentric grailing would be very tedious; he, therefore, tnrned a rough piece of wood, fixed it on to the screw of the slide-rest on the right hand side, taking the winch away, and had a similar piece on the overhead motion, and by fixing a double-angled tool in the slide-rest he was able to cover a large surface in about two minutes, not with concentric grailing, but with a spiral grailing so close that the effect was almost equal to the concentric. Of course the difference between the two would be this, that the concentric grailing would reflect the light at a different angle from the spiral, which in that respect would be inferior, but the difference was so slight that it was found to answer the purpose equally well. In conclusion, he congratulated all turners that they were not obliged to work in the awkward position shown in some of the drawings, and felt sure they would all agree in passing a hearty vote of thanks to Mr. Hasluck for the information he had given in so concise a form. He had heard a clergyman say that it was much easier to preach a long sermon than a short one, as it was by no means easy to condense what one had to say into a small compass. Mr. Hasluck had, however, accomplished his task most successfully.

The vote of thanks was passed unanimously.

The following objects were exhibited at the meeting in illustration of the paper :—

Mr. J. H. Evans, exhibited an ornamental turning lathe, having the spiral apparatus fitted to the back of the lathe head. The particular advantages claimed for this application of the spiral is that it can be used with the oval chuck, and can remain on its place for ordinary turning. Also turned work in ivory and wood.

The Britannia Company, an improved self-acting sliding and screw-cuting gap bed lathe.

Messrs. Elias Churchill & Co., American chucks, guages, combination, and other turning tools.

Examples of ornamental turning in ivory, wood, and metal, were exhibited by several amateur turners and by the following winners of prizes at the competitions of the Turners' Company: — Mr. H. A. Alexander, Mr. E. J. Barber, Mr. John S. Coulson, Mr. G. Freeman, Mr. F. Nickolay; also by Mr. W. A. Barber, and Mr. T. G. Olley.

Miscellaneous.

NOTES ON ECONOMIC PLANTS.

(REFERRED TO IN THE KEW REPORT FOR 1880.)

In the Kew Report for 1880, which was issued in December last, many facts occur in connection with the diffusion of useful or economic plants into the various British Colonies, and also on the subject of clearing up the nomenclature of plants whose botanical origin has hitherto been either unknown or doubtful. Much space is given, as might be expected, to reports from different parts of the world on the cultivation of new and valuable species of *Cinchona.* Thus *Cinchona Ledgeriana* is referred to as follows :—The extraordinary richness in alkaloids which has been evinced by selected strains of this cinchona, under the skilful management of the Dutch Government plantations in Java, has naturally attracted the attention of planters to the importance of cultivating it, as other kinds of cinchona would necessarily stand a poor chance with it in commercial competition. A very large number of applications has been addressed to Kew for a supply of seed. This has been partially responded to, partly through the courtesy of the Dutch Government, and partly by a supply from the Indian Government plantations of Sikkim. A correspondent in Ceylon writes :—" The *Ledgeriana* plants here on our estate 'Conon' are doing uncommonly well, and as far as I can judge, they seem to be growing faster than *officinalis*, and I am not sure that they do not grow faster, and girth as fast as *succirubra*. . . . . From what I hear, our clearing of 25 acres with about 25,000 plants is the largest in the island, and of the best sort." These 25,000 plants were all raised from two ounces of seed. It will be seen from this estimate, that an acre of land will grow a thousand plants. This species has also been introduced to Jamaica, from whence the plants were reported as being in a fine healthy condition. The prospect of establishing this species in Jamaica is considered of the highest importance, inasmuch as the bark grown in Java has realised 17s. per lb.

In the Nilgiris this species seems to grow very satisfactorily, provided the plants are first raised under glass with heat; for it is stated " experiments go to prove that the hills are too cold for the *Calisaya*. It is certainly too cold to raise them from seed in the open air." The writer of the foregoing paragraph further says :—" In Wynaad, men are clamouring for *Calisaya Ledgeriana*, if possible, but anyway, *Calsaya*. There are so many applicants, that I have little hope of getting *Ledgeriana* seed from Mr. Moens. I saw Mr. Cross here soon after he had brought out the *Calisaya de Sante Fé*. The plants looked strong and healthy. I believe, from what Mr. Cross said, the kind will do here, but not in Ootacamund. He said the *habitat* is the canons high up the Andes, where, though near the snow line, there is always a hot wind from the plains. Ootacamund is the centre of the hills. Round the Ghauts might be found suitable spots for it. I have here, at Greenway, 80,000 odd trees of *Condaminea*, in various stages of growth. I went to the Government gardens, and saw the eight or ten-year old *Ledgeriana* trees—some dead, others dying. Up here they will not renew their bark, and consequently die. The *Calisaya* ordinary variety, too, in the gardens, does not throw up a straight stem, but forms a bush rather than a tree. The *Ledgeriana* forms a tree, certainly, and thrives till barked. My *Condamineas* are growing well. Many are ten feet high now—planted in 1877; in four years time they ought to be ready for barking."

Cocoa Plants for Eastern Colonies.

Mr Horne, the Director of the Mauritius Botanic Garden, having visited Fiji, at the instance of the Governor, Sir A. H. Gordon, reported to the Colonial Office that it was peculiarly desirable to introduce into the islands, as well as the Eastern Colonies, "the twelve or thirteen superior varieties of the cocoa plant in cultivation in Trinidad." Arrangements were accordingly made, and in the course of last autumn, seven Wardian cases of cocoa plants were received from Trinidad at Kew, in excellent order; and after examination and re-packing, transmitted to Ceylon, whence it was arranged that portions of the collection should be sent on to Singapore and Fiji respectively. The transmission to Ceylon was fairly successful, and Dr. Trimen has since made the distribution. Individual planters in the East have already largely supplied themselves with cocoa-seed from Trinidad. It was thought that it would be advantageous, however, to have in the Botanic Gardens of the colonies above mentioned, standard collections of varieties for future observation and experiment. In an official report on the subject, Mr. Prestoe, the Government Botanist at Trinidad, remarks:—"The best kinds are by no means well-known. Indeed, with the majority of growers here they are not known at all, and they never notice a difference in the character of the trees nor that of the sample of produce, except in respect of the *Calabacillo*, or 'wild' cocoa, and this they very rarely eliminate. In the whole range of varieties, however, there is a difference in the value-yield of at least one to five. Under these circumstances, the value of the cocoa plants now forwarded should be regarded as of rather a botanical or scientific nature, than as an agricultural or economic one, for immediate effect, for the varieties being separated and described, as far as it is practical, to have them, there is a base for experiments, and tests as to what are their real characters, and what may be done with them in the way of improvement."

Cola Nuts.

Some very interesting particulars are given on the West African trade in Cola nuts, the seeds of *Cola acuminata.* We are informed that the import of these seeds amounted in 1879 to 108,000 lbs. more than in 1878. On the other hand, the export was 58,000 lbs. in excess of the export in 1878. The trade in Cola nuts is an attractive feature in the commerce of the Gambia. The Cola nut is the product of the Sierra Leone district, and the trade in it, both at Sierra Leone and the Gambia, is almost entirely in the hands of women, to a large number of whom it affords the means of livelihood, and in many instances the acquisition of considerable wealth. The nut is largely consumed by the natives of the Gambia; it is of a bitter taste, and produces no exhilarating effect, but is said to possess the power of satisfying for a considerable time the cravings of hunger. For this purpose, however, it is much less used than it is as a luxury. The trade in the article is rapidly increasing.

	lbs.
In the year 1860 the import was about ..	150,000
„ 1870 „ „ ..	416,000
„ 1879 „ „ ..	743,000

The trade in Cola nuts has also spread to Central Africa, and even to the African shores of the Mediterranean.

The plant has been introduced from Kew to the West Indies, Seychelles, Calcutta, Ceylon, Dominica, Demerara, Mauritius, Sydney, and Zanzibar.

Fodder Plants.

Tagasaste (*Cytisus proliferus*), *Adelaide.*—Dr. Schomburgh reports:—"The seeds have grown uncommonly well, the plant reaching a height of four to five feet. There is not the slightest doubt that this plant delights, not alone in our climate, but in any kind of soil and situation....... I do not doubt a moment that this shrub, if sown on the sheep-runs, naturally well covered with soil, will soon become acclimatised, and will stock the runs with a new fodder-plant."

Brisbane.—In these gardens the seed germinates freely in the open air, but makes but little progress in its subsequent growth.

Teosinte (Euchlæna luxurians), *Adelaide.*—Dr. Schomburgh reports:—"I have now cultivated it for the last three years, and no doubt it is one of the most prolific fodder plants. Notwithstanding the prevailing dryness of the two last summers, the hot winds did not injure it, the plants not showing the slightest effect on their leaves, which preserved their healthy green, while the blades of the other grasses suffered materially. The habit of throwing out young shoots is remarkable, to the number, in some plants, especially such as stand in a moist situation, of 50 to 60, with a height of five to six feet. There is one drawback. The plant, as I have already remarked, being essentially tropical in its habits, the ripening of the seed-crop will be problematical with us, as early frosts will kill the plant."

Jamaica,—Mr. Morris reports:—"Treated as a garden plant, the *Euchlæna* has grown well at Castleton gardens, but sufficient experience has not yet been obtained to express an opinion whether it will prove generally suitable as a fodder-plant. A good crop of seed has been harvested and widely distributed for experimental purposes in different parts of the island."

Madras.—The Agri-Horticultural Society report:—"*Euchlæna (Reana) luxurians* continues to grow luxuriantly, seed, and reproduce itself, with so little care and watering as to confirm the opinion expressed in last annual report, that it may be considered a success. It is particularly worthy of growth in private gardens, a few stalks of it giving a green bite to horses in the long dry weather, when change of food is so hard to get. . . . . As a single crop, with a given quantity of water and moderately good soil, the *Reana* will produce, in hot weather, a much greater bulk of green fodder than either lucerne or guinea-grass, which are most commonly grown in Madras for the purpose."

INDIA-RUBBERS.

Under this head a great deal of space is devoted to the several plants which yield the different rubbers of commerce. On the subject of the Central American rubber plant, *Castilloa*, in Ceylon, Dr. Trimen is quoted as follows:—"Two plants have been sent to Calcutta. Those in Burmah are reported to be flourishing. Much better success now attends the propagation, by cuttings, of this fine species. Our largest trees at Heneratgoda have now a circumference of nearly seventeen inches or a yard from the ground, and the trees are beginning to take their true form."

Ceara Rubber (Manihot Glaziovii), Ceylon.—Dr. Trimen says this is still the only species which has flowered. "Seed has been supplied, during the year, to the Government gardens in India (Calcutta, Saharunpore, Ootacamund), and distributed as widely as possible among the planters in the colony, 24,550 seeds having been thus disposed of, as well as 1,879 rooted cuttings. We have also sent small quantities to the Botanic Gardens of Singapore, Mauritius, Jamaica, British Guiana, and Kew, the Acclimatisation Society of Queensland, and Mr. Low, Her Britannic Majesty's Resident in Perak."

Dr. Trimen adds, "this plant is now flourishing in Ceylon in suitable places, and proves very hardy; in the new estates in the Trincomalee district, it is reported to be thriving, but to have shown itself intolerant of wet. In the Nilgiris, I am informed, it is doing well at 2,400 feet; and Major Seaton reports from British Burma that there are 500 and upwards set out and well established in the Mergui plantation."

Jamaica.—Mr. Morris reports:—"This plant is evidently of a very hardy character, and adapts itself readily to the exigencies of culture. Plants at Castleton (600 feet) and at the Parade Garden, Kingston (50 feet) are doing well. At the former gardens, young trees, when about 9 to 12 feet high, were beginning to flower, but the hurricane deprived us of the hope of procuring seed this year. Judging by reports from South America, it is possible that tracts of dry, stony—almost worthless—lands, in the plains, may be turned to good account by means of this cultivation.

Para Rubber (Hevea brasiliensis).—On the cultivation of this rubber plant in Ceylon, Dr. Trimen reports that it "will be probably found to be satisfactory only in rich land, not much above sea-level, where the temperature is high and equable, and the rainfall large. At Peradeniya, the trees are making but slight progress, and suffer from wind, especially in the dry north-east monsoon. At Heneratgoda, their progress is all that could be wished. Our largest trees are now, at three feet from the ground, 16 inches in circumference. During the year, 662 cuttings were raised and distributed. *Hevea* has proved completely unsuited to the climate of Calcutta, but is doing well in Burma and Perak. In the latter place, a tree has flowered sparingly, at 2½ years old, and 35 feet high."

African Rubbers (Landolphia spp.).—On this point it is stated that all the present commercial sources of African caoutchoue belong to the above genus, which is a group of woody climbers, all of which probably yield caoutchouc peculiar to tropical Africa and the adjacent islands. African caoutchouc comes into commerce, both from the west and the east coasts, and only one of the rubber vines is common to both. Three species of *Landolphia* are described as producing caoutchouc on the West Coast of Africa. The form in which West African rubber comes into commerce is somewhat peculiar: it is accounted for by the method of collection, which has been described as follows:—Every part exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly, and forms a ridge on the wound, and stops its flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually by the fingers, and smeared on their arms, shoulders, and breasts, till a thick covering is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water. The three species referred to above are *Landolphia owariensis*, *L. Monnii*, and *L. florida*. From the East Coast of Africa four species are referred to as furnishing rubber of commerce, namely, *L. florida* (before referred to on the west), *L. Kirkii*, *L. Petersiana*, new and undescribed species, and a species, though distinct, not yet sufficiently known to admit of scientific description. The following extract from a report to the Foreign Office by Mr. Holmwood, the Vice-Consul at Zanzibar, is descriptive of the mode of collecting the rubber:—"The process consisted in cutting clean slices of bark from the trunk and branches, from three to ten inches in length, and from ½ to ¾-inch in breadth. The cuttings were made sometimes from one side only, but generally they were scored all over the tree, about half of its bark being thus removed. The method of making the balls of rubber—which average two inches in diameter—is as follows:—A quantity of milk is dabbed upon the forearm, and being peeled off, forms a nucleus. This is applied to one after another of the fresh cuts, and being turned with a rotary motion, the exuding milk is wound off like silk from a cocoon. The affinity of this liquid for the coagulated rubber is so great, that not only is every particle cleanly removed from the cuttings, but also a large quantity of semi-coagulated milk is drawn away from beneath the uncut bark, and during the process, a break in the thread rarely occurs. By working hard, one person can collect 5 lbs. of rubber per diem, though the average is one half this amount. I was assured, however, that in the interior, where the trees were large, it is no uncommon thing for one man to collect 7, or even 9 lbs. in a day. The regular season for the collection of india-rubber lasts from about the middle of May till the first week in December. This has little connexion, however, with the state of the tree, but is owing to the natives being generally engaged during, and for some time after, the rainy season in cultivating their lands."

He further reports, that, in the districts of Mungao and Kilwa alone, india-rubber "has created a new trade, which finds profitable employment for all those classes whose means of subsistence came to an end with the suppression of the illegal slave trade. The total exports from these places now (1880) exceeds 1,000 tons annually. Since last season the price has risen from £140 to £150 per ton, and there seems no reason to suppose it will ever again fall to the former figure." With regard to the destruction of the rubber vines by the collectors, Vice-Consul Holmwood takes a somewhat gloomy view. He says it is "admitted that, while three years ago the supply of india-rubber was altogether derived from the country within 50 miles of the coast, the great bulk was now procured from Mahenge and Ubena, countries distant 150 to 200 miles from Kilwa; the supply from the more adjacent districts, having, moreover, greatly fallen off, and, in some instances, entirely ceased."

Consul O'Neill more recently remarks, in his report for 1880, on the trade of Mozambique:—"It is curious to note the marvellously rapid development of the india-rubber industry. In 1873, only £443 worth of india-rubber passed through the Custom-house of Mozambique; in 1876, it reached the value of £22,198, and in 1879, it exceeded £50,000. It would seem, now, to have reached its climax, while the present rude method of collecting this produce prevails, and until communications with the interior are properly opened up, for the careless cutting of the trees by the untaught hands of the natives has resulted in the destruction of enormous tracts of india-rubber forests near the coast."

From specimens of rubber-yielding plants received at Kew from Sir John Kirk, it seems that one of the Zanzibar plants is a species of *Landolphia* hitherto unknown to science, and now proposed to be called *Landolphia Kirkii*, in honour of Sir John Kirk. With regard to the mode of collecting the rubber from *Landolphia Petersiana*, Sir John Kirk thus describes it in a report to the Foreign Office:—"The mode of preparation of this india-rubber differs essentially from either of the other two kinds, the juice being here gathered in a fluid state, by tapping, and coagulated by heat, or in some other way, similar to that used in Madagascar or the Brazils. The product, however, is said to be of an inferior quality.

On the subject of Bornean caoutchouc, the Kew report says:—"The most authentic information on the caoutchouc-yielding species of North West Borneo is apparently that contributed by Mr. Treacher to the "Journal of the Straits Branch of the Royal Asiatic Society," for July, 1879 (p. 58). He enumerates no less than eight, with the following names:—

"1. Manungan pulau (*i.e.*, Manungan proper).
"2. Manungan bujok.
"3. Manungan manga (light coloured bark).
"4. Manungan manga (dark coloured bark).

"From the above is obtained the gutta lechak or gutta susu of commerce. (*Gutta* in Malayan means gum; *lechak*, elastic; *susu*, milk).

"5. Serapit larat.
"6. Serapit pulau.

"The produce of these is only used to increase the weight of the manungans, the milk not hardening sufficiently of itself.

"7. Bertabu or Petabo pulau.
"8. Bertabu or petabo laut.

"The produce of these is no longer marketable. The different plants would appear to be accurately distinguished by the native collectors; and if the best of them are to be sought and brought into cultivation, their precise botanical identification becomes important.

"No. 1 of the foregoing list is referred to as a new species of *Willughbeia*, the name proposed for it being *Willughbeia Burbidgei*.

"No. 2 is *Leucenotis eugenifolius*.

"Nos. 3 and 4 are supposed to be species of *Willughbeia*, and *W. Treacheri* is proposed for No. 5.

"The remainder would at present seem to be undeterminable. All the above species belong to one natural order, namely, *Apocynaceæ*. Other caoutchouc yielding plants are referred to in the report, which are, however, of minor importance as compared with those just enumerated.

"Regarding the collection in Perak of *Gutta singgarip*, the produce of *Willughbeia Burbidgei*, the following description is given:—"The stem is generally ringed at intervals of 10 to 12 inches, and the milk allowed to run into vessels made of palm or other leaves, cocoa-nut shells, or anything available for the purpose; it continues to flow for some time, but after flowing for some minutes, it gets very watery and thin. One flow will yield from five to ten catties of the coagulated caouchouc. When raw, it has the appearance of sour milk, and to coagulate it the natives add salt, or salt water. When freshly coagulated, it is quite white, which gradually changes to a darker colour. It keeps white inside, and on cutting, it presents a foveated appearance, the cells containing water and salt, which have become enclosed during coagulation. In texture it is soft, very spongy, and very wet."

TEA CULTIVATION.

India.—The following statement, quoted from the *Madras Mail*, gives a striking picture of the progress made by this industry:—"In 1850, the area under this plant was approximately estimated at not more than 1,000 acres, and the total out-turn of tea at little over 250,000 lbs. At the present time, the area under plant may be put down at 206,700, viz.:—Assam, 85,000 acres; Cachar, 47,000 acres; Sylhet, 18,000 acres; Darjiling and Terai, 34,000 acres; Dehra Doon, 4,300 acres; Kangra Valley, 7,400 acres; Kumaon, 4,400 acres; Chittagong, 4,200 acres; Chota Nagpore, 3,300 acres; producing about 40,000,000 lbs. of prepared tea, and representing a capital invested not far short of fifteen millions sterling, while about two millions sterling are spent annually in India in the working and up-keep of the plantations. Of the advantages accruing to India—directly to the people, and indirectly to the Government—from the disbursement of so large an amount of money, there can be no question. It will be seen that, of the total area of 207,600 acres brought under cultivation, 150,000 acres lie within the administrative circle of the Chief Commissioner of Assam; and the statistics of that province demonstrate the continuous and rapid progress of its revenue and general prosperity during the period in question—a prosperity which may be fairly claimed as being almost entirely due to the beneficial influence of the tea industry. There still remains, however, a vast field for future development, not merely in the production of tea, but for almost every kind of crop grown in India, more especially rice.

United States.—The following experiment, in the direction of enabling the United States to grow its own tea supply, seems to be worth noting. The Commissioner of Agriculture reports that Mr. John Jackson, who had had the management of tea plantations in Assam, had purchased the estate of Dr. Jones in Georgia, on which were growing patches of neglected tea plants of all sizes, most of them having sprung from a few old trees set out by Dr. Jones in 1850. Mr. Jackson laid out a tea garden of 100 acres, and made samples of tea from the leaves of the older plants. Those were sent to Messrs. W. T. and H. Thomson, of 38, Mincing-lane, who reported:—"The samples represent that of a high type. The flavour, though not strong, is remarkably fragrant. The infused tea indicates somewhat too light fermentation, but has all the characteristics of high quality. There can be no doubt, apparently, as to the feasibility of tea cultivation in the Southern States. The ultimate success of the experiment will probably depend upon the supply of labour at a sufficiently cheap rate, to enable the produce to compete with foreign tea."

Amongst the various things treated of in the Kew report, besides those more important articles of commerce which have been referred to here at length, are paper materials from Indian fibres and wood pulp, turpentines from Indian coniferous trees; gambier, or terra japonica, from *Uncaria gambir;* coffee diseases in Ceylon, Fiji, and Venezuela; and many other points of interest, both to planters in our colonies, and to the commercial man at home.

SULPHUR MINES OF SICILY.

The mining industry of Sicily is entirely confined to the production of sulphur, in which mineral the island is very rich. The sulphur country lies to the south of the Madonia chain of mountains, embracing nearly the entire provinces of Caltanisetta and Girgenti to the seaboard, and part of that of Catania; in addition to these, there is a group of mines in the south of the province of Palermo. The principal centres of this industry are at the mines of Caltanisetta, Castrogiovanni, Montedoro, San Cataldo, Serradifalco, Sommatino, Valguanera, and Villarosa, in the province of Caltanisetta; Aragona, Casteltermini, Cattolica, Cianciana, Comitini, Favara, Grotte, and Racalmuto in the province of Girgenti; and Lercava in that of Palermo. Vice-Consul Rose states that sulphur is met with at a great variety of depths below the surface of the land, in seams varying considerably in thickness. In very rich lands the veins do not average more than 6½ to 27 feet in thickness, with sterile strata, from a few inches to three feet and over, intervening, while in those less productive, the sulphur seams lie separated by barren strata of much greater density. The rock containing the mineral is detached from the mass by the use of a sharp pointed pickaxe, weighing about 15 pounds, and brought to the mouth of the shaft, which is like an inclined plane running down the earth with steep steps roughly cut in the rock, forming, almost invariably, the only means of access to the works at the bottom of the mines. The ore is excavated by men, assisted by small gangs of boys working under them, who carry heavy pieces of the rock to the surface, as it is broken up by the miners, and deposit them in localities allotted to each pickman, where the ore is piled up in large heaps preparatory to its being measured, to ascertain the quantity of "cassa" excavated by each man. The "cassa" is the measure by which the quanlity of sulphur ore dug in Sicilian mines is reckoned when paying the miners for their labour, but differs in dimensions in different mining districts of the island. The boys employed in transporting the mineral carry from 40 to 60 pounds weight, according to their ages, which range from ten to eighteen years, from pits often over 275 feet deep, making twenty to forty journeys a day. Water is frequently met with before reaching a seam of sulphur, and up to the present it has been one of the greatest obstacles in the way of mining engineering in Sicily, greatly increasing the cost of working. The depth of 190 feet is rarely obtained without water oozing through imperceptible fissures in the rock, and this frequently stops all operations by submerging the works. To provide against this, the old-fashioned hand-pump was used, and this gradually giving way to steam power, has reduced to a minimum the fear of mishaps occurring by flooding. It is very rarely that any explosions occur in the Sicilian mines, small earthenware lamps containing oil—the flames of which are left naked—being used in the mines without the slightest apprehension of accidents happening. Safety lamps are not known in Sicily. The following is the method employed in smelting the ore, after it has been separated from the rock by heat or steam. When a sufficient quantity of the ore is collected on the surface to form a pile—called, with the masonry built round it to keep the liquid sulphur from escaping, a "calcarone"—the mass, which is heaped up high, is set fire to by igniting straw impregnated with sulphur placed on the top of the calcarone, or kiln, for the purpose, and the kiln left to burn, the sulphur once ignited acting as its own fuel. From seven to eight days after the first sulphureous fumes are emitted, which indicate that the mass has caught fire, and when ample time has been allowed for a certain quantity of the ore to melt, the masonry mentioned above is pierced, and the liquid sulphur, of a deep amber colour, is permitted to run out into square wooden moulds, called "balate," the sulphur, on cooling, hardening and turning to a bright yellow. The fusing by this process, in which only a small quantity of the ore is lost, may last from thirty to ninety days, the time occupied depending on the size of the kiln. There are seven qualities of sulphur known to the trade—first quality, best second, good second, current second, best third, good third, and current third. The several qualities are not determined by test, but simply by the purity of colour; the brighter the yellow, the more free is the quality considered of extraneous matter. The total quantity annually smelted may be estimated at 390,000 tons, and its value when distributed at the shipping ports of Palermo, Catania, Licuta, Porlo Empedocle (Girgenti), and Terranova, at £1,765,000. The wages of miners, and others engaged in the production of sulphur, range from one shilling and fourpence to two shillings per day of six to eight hours. Pickmen are almost invariably paid according to the quantity of mineral they excavate.

Correspondence.

STAINED GLASS.

In Mr. Day's paper, on the above interesting subject, I was rather astonished at not finding any mention of such names as Benedict, Bede, and Wilfrid. Some notice of the old church of St. Peter's, Monkwearmouth, ought to have been made.

The following is an extract from the *Mirror of Literature and Arts*, published in 1834:—"To the labours of the cloister we owe everything connected with literature and fine arts: mark the pane rich in colour and blazing in its glory! We derive it from Benedict (or Biscop) the monk." The Puritan, Bale, censures our saint for being the first to introduce it. In Butler's "Lives of the Saints," vol. 1, page 113, we read "St. Biscop also brought over glaziers from France, for the art of making glass was then unknown in Britain." In St. John's Cathedral, Salford, St. Biscop is represented with a stained-glass window in his hand.

The following passage is found in an article on "Glass Painting" in *Cassell's Technical Educator*, vol. 2. p. 110:—"Bede says that glass and glass makers were brought to England as early as A.D. 674."

In the *Annual Register of Antiquities*, published in 1761, on the subject of the use of glass in windows, page 150, the following appears:—"It appears by our historian (Simon Dunelm, Hist. Ang. Script, p. 96), that it did not reach our island till the seventh century; when it was brought hither from France by Benedict."

I give these extracts to show that St. Peter's had something to do with the early glass of this country. (*Vide* "Abbeys and Abbots," p. 9, published by S. V Wells, Ardwick). I do not like Mr. Day's reference to the "trumpery decorations of wax and tinsel, and paper flowers that desecrate (?) the altars in the churches abroad" (*Journal*, p. 302). I have been several years abroad, and never saw what Mr. Day states. I can only say this, let us take lessons from our old churches at home and abroad, and then stained glass windows will be more perfect in this country.

G. S. Mitchell.

Nottingham.

Mr. L. F. Day, in the closing remarks of his interesting paper on stained glass, pointed out what a glass painter of the present style should be, and I doubt not he could have mentioned some such as Messrs. Clayton and Bell, and Mr. Ion Pace and others, whose works now speak for themselves. It was my lot in early life to come under the tuition of Mr. R. Wynn, a glass painter of some note. He gave lessons in his art to the Princess Charlotte; but what I consider him remarkable for was his communication in the year 1817 to the Society of Arts ("Transactions," vol. xxxv.), and for which he was voted the sum of twenty guineas, viz., for receipts for enamel colours for staining glass and the method of applying the same. It occupies twenty-three pages, and in connection with this subject would, I think, bear a reprint, being a most lucid description of the art and mystery of the profession of glass painting.

David G. Laing.

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General Notes.

The Milan Exhibition.—This Exhibition cost, according to the *Monitore Industriale*, £130,000, while the admissions produced £154,000, thus leaving £24,000 profit, £22,000 of which has been returned to the subscribers. This success has led to another

Exhibition being projected at Bielha, to open in the summer, when the Alpine Congress is held.

PROPOSED TUNNEL BETWEEN ITALY AND SICILY.—A project for a tunnel between Reggio and Messina has been presented to the Minister of Public Works by the "Società Veneta di Publicha Costruzioni." The author of this project is Signor Federico Gabelli. The total length of this tunnel will be 13,200 metres, including the inclined approaches, or 1,000 metres longer than the Mont Cenis Tunnel. The maximum depth of water over the proposed tunnel will be 110 metres, the ends of which, at this place, would be 35 metres below the bottom of the sea. The direction of the submarine portion of the undertaking will be from S.E. to N.W., between the Punta del Pizzo and Sta. Agata. The inclined approaches, 4,500 metres in length, will run parallel with the shore for a certain distance, and then, with a curve of 350 metres radius, join the tunnel under the straits, which will be 4,200 metres long, or rather more than 2½ miles. The gradient of the inclines is fixed at 2½ per 100, or the same as that on the line from Turin to Genoa at the Giovi Tunnel. The submarine portion will have a fall of ½ per 1,000 from the centre towards the shore ends, in order that the filtrations of water may drain and be pumped out by engines, which will be fixed at the vertical shaft from which the tunnel will be driven. From a geological examination of the locality, it would appear that the bottom of the straits consist of crystalline rocks such as granite, gneiss, and mica schist. The quatertiary formation that covers the crystalline rocks, both on the Sicilian and Calabrian coasts, is not supposed to run deep, and should fissures occur in the older formations, through which it is proposed to drive the tunnel, they are probably filled up with clay or mud, so that there will be no fear of water finding its way into the tunnel. According to Signor Gabelli, the cost of the undertaking will not exceed 65 millions of lire (£2,600,000), and could be completed in six years.

SMOKE ABATEMENT EXHIBITION.—This Exhibition, which has been open at South Kensington since November 30th, was formally closed on Monday, the 14th instant, by a meeting of the committee and exhibitors, which was held in the Royal Albert-hall. Mr. Ernest Hart presided, and opened the proceedings by briefly reviewing the work that had been done in connexion with the Exhibition. The Exhibition had brought to the knowledge of the public a great number of inventions well calculated to abate smoke, and it had shown that the abatement of smoke could be applied to many trades to which it had been supposed to be inapplicable. The Exhibition had been eminently satisfactory. The Duke of Westminster had deputed Mr. Cundy to report to him upon the most successful inventions for smoke abatement, with a view to their introduction in the houses on the Westminster estate. Mr. Shaw-Lefevre, M.P. (First Commissioner of Works) had given instructions that a certain number of articles should be purchased, with a view to their introduction into the public offices. The total number of visitors had been 106,000, 40,000 of whom had been admitted by payment. There was a loss of £800 on the receipt and expenditure account, but this was no more than the committee had anticipated. Nearly £1,000 had been spent upon testing appliances. The great success of the Exhibition was due, above all, to the zeal, courtesy, and ability of their honorary secretary, Mr. Coles. The meeting concluded with votes of thanks to Mr. Coles and other officers, and to the Chuirman.

LILLE INTERNATIONAL EXHIBITION. — The opening of the Exhibition is deferred until the 1st April, and goods will be received at the Palais Rameau up to the 15th March. Foreign exhibitors or their representatives must fulfil the Customs' formalities on the receipt and re-forwarding of their cases, the opening of which will take place, as far as possible, inside the palace. M. Paul Cambon, Prefect of the Department of the Nord, has accepted the honorary presidentship, while M. Géry Legrand, Mayor of Lille, has been elected president, and MM. Violette and A. Ozenfant, vice-presidents.

CHANNEL TUNNEL.—At a meeting of the Submarine Continental Railway Company, held on the 20th January, 1882, Colonel Beaumont described the process of making the tunnel, by means of machinery designed by himself and Captain English. He said, "Captain English's and my own machine is now heading at the rate of 12 yards per day of seventeen hours. We have every confidence that the machine which will next be put into the heading will drive at the rate of 1 yard of the heading per hour. If you have the same thing done on the French side, that will be 2 yards per hour, or in round numbers, 50 yards per day. . . The dirt that is cut by the machine is delivered in the waggons, so that this advance is actually got by the manual efforts of two men only. One man is employed at the face of the machine, and another man behind, driving it, and these two represent the only manual labour employed at the machine. The ventilation, which is of course a very important matter, an -an absolute *sine quâ non* in connection with the question of traffic through the tunnel, so far as the construction of the works is concerned, is provided by the air which is necessary to work the boring machine itself. . . . . The amount of air which is required for working the machine is quite sufficient to keep the headings perfectly ventilated. . . Compressed air is now in such a position that it becomes quite a measurable quantity. You can estimate the amount of coal you have to burn to move a given amount of dirt . . . By the use of compressed air, and burning one pound of coal, you will move three tons a mile on a railway."

TEA AND SILK CULTURE,—Mr. Ernest Tye, Secretary of the Italian Tea Districts Association writes to say, that the wages of ordinary coolies in Assam, are five and six rupees per month, and not nine rupees, as stated by Mr. Cochran (see *ante*, p. 282). Mr. Tye adds that the cost of producing Indian tea in 1880, which ranged from 1s. to 1s. 3d. per lb., includes all charges for carriage, freight and brokerage, commission, &c.

POSTAL PARCELS TRAFFIC IN BELGIUM.—In the year 1880, according to the Report of the Minister of Public Works, there were conveyed over the State railways, and lines in connection, by passenger train (tariff No. 1, called express in the regulations), 165,261 postal parcels *(petits paquets)* up to 2 kilogrammes (4·4 lbs.) weight, inclusive. Taking these at an average weight of 1 kilogramme (2·2 lbs.) each, gives a total weight of about 165 tons, which produced the sum of 56,971 fr. (£2,279). Small parcels at the same tariff, from 3 to 5 kilogrammes (6½ to 11 lbs.) in weight, numbered 277,337, which, taken at an average weight of 3 kilogrammes (6½ lbs.), give a total weight of about 832 tons, with a receipt of 108,478 fr. (£4,339). Again, the number of postal parcels up to 5 kilogrammes (11 lbs.), inclusive, sent by fast goods train (tariff No. 2), was 517,400, which, at an average weight of 3 kilogrammes (6½ lbs.), give a total weight of 1,552 tons, with a receipt of 232,505 fr. (£9,300). Adding these three classes together, we get a total number of more than 960,000 postal packets, of a total weight of over 2,500 tons, producing the sum of 397,950 fr., or £15,918, in a year, for a country of only 11,313 square miles area, or about the size of Wales, with a population, however, of about 6,000,000, or 530 to the square mile. Moreover, these figures only give the internal post parcels traffic, as the international arrangement has not been in force for a sufficient length of time to allow of statistics being prepared.

PROJECTED UNDERGROUND RAILWAY AT NAPLES.—The *Pungolo* of Naples gives the following particulars of an underground or metropolitan railway that has been submitted to the municipality of that city by some English capitalists. The plans comprise two distinct lines of railway, one above ground of narrow guage, skirting the hills above the city so as to unite the various suburban hamlets and villages with the principal points of Naples, by means of another line which will be of the ordinary 4 ft. 8½ in. guage underground. These two lines are to connected at the station of Vomera by an elevator. The underground line will have thirteen stations, viz.:—Fuorigrotta, Mergellina, Vomero, Rione Principe Amedeo, Piazza Dante, San Gennaro dei Poveri, Cristallini, Reclusorio, Railway Station, Foria, Duomo, Post-office, and San Ferdinando—all of which, with the exception of Fuorigrotta, will be underground. The trains are to run in each direction every ten minutes, three minutes being allowed from station to station, and half a minute for stoppage. The stations and carriages to be lighted with gas. Compressed air will be used as motive power in the locomotives, and the carriages, which are to be of four classes, are to be built on the American plan. From the plans and estimates presented to the municipality, we understand that the total cost of this undertaking will amount to 24,000,000 lire (£960,000), and that three years, working day and night, will be required for its construction.

THE CENSUS OF ROME.—The results of the census taken at 31st December, 1881, have been published, and from this it appears that the increase of the population during the last 10 years has been greater than was expected, as may be seen from the following table:—

	1871.			1881.		
	Males.	Females.	Total.	Males.	Females.	Total.
In the City	119,167	100,441	219,608	145,594	126,430	272,024
In the Suburbs	7,394	2,354	9,748	9,192	3,351	12,543
In the Agro Romano..	12,706	2,422	15,128	12,541	3,184	15,725
	139,267	105,217	244,484	167,327	132,965	300,292

Increase During 10 *Years.*

	In City.	Total.	Per cent. City.	Total per cent.
Males.............. ...	26,427	28,060	18·1	20·1
Females	25,989	27,648	25·8	26·2
	52,416	55,708	23·8	22·8

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 22.—"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. EMERSON DOWSON. Lord ALFRED S. CHURCHILL will preside.

MARCH 1.—"The Teaching of Forestry." By Colonel G. F. PEARSON. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., will preside.

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S.

MARCH 15.—"Gas for Lighthouses." (Illustrated by an Exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM.

MARCH 22.—"Telephonic Communication." By LIEUT.-COL. C. E. WEBBER. The Earl of CRAWFORD AND BALCARRES, F.R.S., will preside.

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 28.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Practical Science of Moscow.

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

FEBRUARY 23.—"Methods and Standards of Photometry." By HAROLD B. DIXON, M.A., Dr. A. W. WILLIAMSON, F.R.S., will preside.

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

FEBRUARY 17.—"The Depreciation of Silver as it affects India." By J. M. MACLEAN. A. J. BALFOUR, M.P., will preside.

MARCH 17.—"Village Life, and the Village System in the Bombay Presidency." By W. G. PEDDER.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Second Course is on "Recent Advances in Photography." By Captain ABNEY, R.E., F.R.S.

LECTURE 4, FEBRUARY 20.—Permanent printing processes. Application of photography in drawing. Mechanical printing processes, including photo-engraving.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Capt. W. de W. Abney, "Recent Advances in Photography." (Lecture IV.)

British Architects, 9, Conduit-street, W., 8 p.m. Adjourned Discussion on Mr. J. Boult's paper, "Uniformity in Building and Sanitary Regulation."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. 1. Rev. Dr. Schön, "The Haussa Language of Central Africa. 2. Mr. Robert N. Cust, "African Scholars."

Victoria Institute, 7, Adelphi-terrace, W.C. 8 p.m. Mr. J. Hassell, "The Theory of Evolution taught by Hæckel, and held by his followers, examined."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. E. B. Tylor, "Mythical and Magical Beliefs."

TUESDAY, FEB. 21...Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "The Mechanism of the Senses." (Lecture VI.)

Civil Engineers, 52, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. Coleman's paper, "Air-Refrigerating Machinery and its Applications."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. John Glover, "The Tonnage Statistics of the Decade 1870-80." A sequel to two previous papers on the decades, 1850-60 and 1860-70.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. J. E. Price, "Note on Aggri Beads." 2. Mr. A. Macfarlane, "Analysis of Relationships of Consanguinity and Affinity." 3. Mr. A. W. Howitt and the Rev. Lorimer Fison, "From Mother-right to Father-right."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. F. Moore, "List of the Lepidoptera collected by the Rev. J. H. Hocking, chiefly in the Kangra District, N.W. Himalaya, with Descriptions of new Genera and Species." 2. Mr. G. A. Boulenger, "Note on a Specimen of *Phyllomedusa hypochondrialis* lately living in the Society's Gardens." 3. Prof. St. George Mivart, "Notes on the Anatomy of *Erithizon dorsatus*."

WEDNESDAY, FEB. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Emerson Dowson, "The Production and Use of Gas for Purposes of Heating and Motive Power."

Geological, Burlington-house, W., 8 p.m.

THURSDAY, FEB. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. Harold B. Dixon, "Methods and Standards of Photometry."

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. R. Von Fischer Treuenfeld, "Siemens's System of Railway-gong Signalling."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Rev. Dr. W. Sparrow Simpson, "The Organist Composers of St. Paul's Cathedral."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. H. C. Bannister, "Some of the Underlying Principles of Structure."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. L. Sclater, "The Geographical Distribution of Animals." (Lecture II.)

Inventors' Institute, 4 St. Martin's-place, W.C., 8 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

FRIDAY, FEB. 24...Royal United Service Inst., Whitehall-yard, 3 p.m. Mr. W. Gardner, "Machine Guns, and how to use them."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., Prof. Odling, "Sir B. C. Brodie's Researches in Chemical Allotrophy."

Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. T. Charters White (President), "The Histological Development of the Larva of *Coretha plumicornis*."

Clinical, 53, Berners-street, W., 8½ p.m.

Browning Society, University College, W.C., 8 p.m. Mr. J. T. Nettleship, "Browning and the Plastic Art."

SATURDAY, FEB. 25...Sanitary Protection Association (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m.

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. G. Gore, "The Influence of the Form of Conductors on Electric Conduction Resistance." 2. Professers Ayrton and Perry, "Faure's Accumulator, and a Simplified Form of Dispersion Photometer."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Watkiss Lloyd, "The Iliad and Odyssey." (Lecture II.)

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FRIDAY, FEBRUARY 24, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The fourth and concluding lecture of Captain Abney's course on "Recent Advances in Photography" was delivered on Monday last, the 20th instant. Captain Abney began by referring to the influence of soluble bromides in gelatine plates, and showed experimentally that the effect of a soluble bromide was not only to retard the action of the developer, but also actually to undo the work executed by the action of light on the silver bromide, since it liberated bromine in the light. The question of halation, and its causes and remedies, was treated at some length. Mr. Warnerke's sensitometer was shown, and its action explained. The different effects of the tablet of luminous paint which Mr. Warnerke employs, upon the different haloid salts of silver, were referred to, and illustrated experimentally. Mr. Bolas's method of obtaining a positive picture by means of a reversal of the image was described, and examples of its results were shown upon the screen. The method of measuring the length of exposure given by a drop shutter, by means of a vibrating tuning-fork, was described and illustrated experimentally. The lecture concluded by the exhibition of some of Mr. Francis Galton's composite portraits upon the screen.

After the lecture, a cordial vote of thanks to Captain Abney was carrried on the proposition of Sir Frederick Bramwell, F.R.S., the Chairman of the Council, for the admirable way in which he had treated so extensive a subject as Photography in the limited time at his disposal.

The lectures will be printed in the *Journal* during the summer recess.

PHOTOGRAPHIC EXHIBITION.

The Exhibition of Photographic Appliances will be closed after Saturday, February 25th, on which day it will be opened till four o'clock p.m.

The demonstration of some of the more recent methods of photography printing, provisionally announced for Monday evening next, is postponed. Due notice will be given of any future arrangements for the purpose.

A list of additions to the Exhibition since the publication of the catalogue will be found on p. 397.

SOCIETY OF ARTS PATENT BILL.

The Committee by which this Bill was prepared in the first instance have, with the assistance of the Parliamentary draftsman who drew the Bill, thoroughly revised it in accordance with the conclusions to which they were led by the discussion on the Bill. The principal alterations in the Bill are in the direction indicated in the concluding remarks of the Chairman, Sir Frederick Bramwell, F.R.S., reported in the *Journal* of December 30th, 1881. The Committee have reported to the Council, and the Council have finally approved the Bill in its altered form. A revised edition of the Bill has been printed, and can be obtained on application at the Society of Arts Offices, price 6d. The Council have now under consideration the measures which must be taken with a view to the introduction of the Bill into Parliament.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

EXTRA MEETING.

Thursday, February 16th, 1882; Captain W. de W. Abney, R.E., F.R.S., in the chair.

The paper read was:—

PHOTOGRAPHY BY THE ELECTRIC LIGHT.

By H. Van der Weyde.

Over six years ago, I was challenged, during a foggy November day, by a desperate London photographer, to invent a method of taking good photographs without daylight; or, as he jocularly put it, "Why don't you Americans bottle your daylight, and send it over to us?" and he assured me there were "millions in it."

I don't know whether it was the prospect of "millions," or the great pleasure I have always felt in overcoming difficulties, that induced me to lay aside my palette, and turn my studio into a laboratory. I think my feelings were a little mixed.

I had already invented an improved model for building glass-houses, on the principle that every pane of glass visible to the sitter should face him at an exact right angle; and placing the glass in the zig-zag crossing of imaginary diverging lines from the usual sitter's place at each end of the studio effected this.

In looking at the results of all former attempts of taking portraits by artificial light, kindly shown me by the late Wharton Simpson, late editor of the *Photographic News*, and I think, a member of this Society, although I found some were very remarkable, they were all, from an artistic point of view, failures; even the best results suggested a metallic or varnished surface, with glittering high lights, dense shadows, and ghastly reflections.

Instead of attempting to do anything better with artificial light, I first tried to condense the actinic rays of London daylight—when I could catch them—for which purpose I constructed a plano-convex water lens out of two large plates of glass, one bent by heat to the depth of eight inches, which had to be repolished by hand. I believe it was the largest lens ever constructed; it measured six feet and six inches in diameter, and held nine hundred and eighty-seven pounds of filtered water—and the first time I tried to fill it, not having calculated upon the immense weight of this water, although the glass was three-quarters of an-inch thick, it burst over me with a loud explosion, and I was overwhelmed, but, as you perceive, not quite drowned, though the point of one of the flying pieces of heavy jagged spears of glass pierced through my forearm between the bones, and laid me up for six weeks; but that is only a detail in the life of an inventor. So I set at it again, reconstructed my lens, and finished this experiment with a conviction that I was on the wrong track.

I then began experimenting with artificial light, such as the magnesium and the electric light from a Grove battery. I constructed a copper reflector with a silver lining, and having had enough of the water lens, ordered the largest dioptric lighthouse lens that could be made; the reflector and lens were each over four feet in diameter.

It now occurred to me that the great difficulty to be overcome had not been an inadequate quantity of artificial light, but that the construction of the relative position of its rays is diametrically opposite to that of daylight. In daylight we are flooded with a soft embrace of converging rays giving soft edged shadows; in artificial light we are struck with the sharp darts of diverging rays from a point, throwing sharp edged shadows; and in trying reflectors to lessen this hard effect, we only made a war of rays around the sitter, in which the direct rays always have the best of it, and overexpose the high lights before the others have had sufficient time to perform their part.

The question was not to discover a better artificial light, but to turn and twist its diverging rays from a point, so as to concentrate them, and, so to speak, make them embrace instead of strike the sitter. This was the supreme difficulty I had to conquer.

In continuing my experiments, I sought to obtain, first, parallel rays from the parabolic reflector, and then to condense them into converging rays by the dioptric lens; and I at this time adopted the most important point in my invention; it was a small saucer, or concave mirror, about four inches in diameter, placed close to the light, so as to hide it from the sitter, and prevent any direct rays from leaving the reflector.

But I found that the silvered interior of my reflector was a mistake. It not only condensed all heat rays, and baked the sitter, but it also polarised the light. So I whitewashed the interior, and from that moment I saw my hopes realised, for I produced at last an artistic portrait with tender crisp high lights, which did not need retouching, and full of modelling and transparency in the shadows. I tried to do without the condensing lens, but found my light not powerful enough; and it was not until I used a powerful dynamo-machine, worked by an engine, that I could dispense with it.

I now went to my friend who told me there were millions in it; but he, and all other photographers in London whom I approached, were too sceptical to invest; they refused the millions or any share in them, so that I was compelled to exploit the invention myself, and with that view bought the lease of my present house, now nearly five years ago. Its slate roof, ladies and gentlemen, is still intact, and I intend that it shall remain so.

The first instance on record of gas being literally turned into electric light was at my establishment. I had my gas-engine put up, September, 1877, in direct opposition to the advice of the manufacturers of my electric machine. I never use an electric lamp, but, as you see, have invented a much more practical arrangement for my purpose.

I simply bring my carbons together by a movement of the hand. The positive 20-millimetre carbon is stuck right through the saucer, and can be pushed in from time to time as it burns. The negative 15-millimetre carbon, fastened in a rod which passes through the back and centre of the reflector, is also adjustable. The saucer and positive carbon being fixed to a flexible brass rod, can be made to approach the other carbon, by simply pulling the cord attached, and which passes through the back of the reflector, and over a small drum. I first designed another position for the carbons on the same principle, but find this better, as the reflector gets the full benefit of the strongest rays.

If there are any photographers here who wish to know whether they can make use of my invention in this country, my answer is, yes. Two of the richest members of the profession I understand, make use of it in London, and such being the case, all others are quite welcome to it. The leading photographers on the Continent are not only using my invention, but are good enough to recognise the inventor.

So, gentlemen, I continue to photograph without daylight—in fact, I never took, and never will take, a photograph by daylight.

After the reading of the paper, Mr. Van der Weyde proceeded to take several portraits of the Chairman by means of his arrangement for producing the electric light, which has been fitted up for the purpose, the machine used to generate the light being the Siemens generator, driven by the Crossley engine, which had been used during Captain Abney's lectures. The light was then turned upon the audience, and several more or less successful photographs were taken of the room by its aid, the room being also illuminated by a Sugg gas-burner of 200-candle power, lent by Messrs. William Sugg and Co., and by a magnesium lamp lent by Mr. F. W. Hart. At the conclusion of the experiments, a vote of thanks to Mr. Van der Weyde was proposed by the CHAIRMAN, and carried unanimously.

INDIAN SECTION.

Friday, February 17, 1882; A. J. BALFOUR, M.P., in the Chair.

The paper read was—

THE DEPRECIATION OF SILVER AS IT AFFECTS INDIA.

By J. M. MACLEAN.

I am afraid that some members of the Society may have thought it unnecessary, and even presumptuous, for me to take as the subject of my paper of this evening the effects of the fall in the value of silver on the economical condition of British India, inasmuch as the silver question has been already treated, from different points of view, in papers read before meetings of the Society in the year 1878. But, while the authors of both these papers—Colonel Smith, who proposes certain changes in the Indian currency, and the late Mr. Ernest Seyd, the most ardent, the ablest, and the most indefatigable champion of bi-metallism—started with the assumption that the depreciation of silver was a calamity for India above all other countries, and offered remedies of their own to prevent the same cause from working further mischief, I have set before myself the humbler, but, I trust, not less useful, task of putting aside theories altogether, of taking nothing for granted, and of tracing out the actual results—so far as Indian commerce and industry are concerned—of the great change that has occurred in the relative value of silver as compared with gold. We have gained much valuable experience since the matter was last discussed at a meeting of the Society of Arts, and are now placed in a better position for judging what is the real extent of the losses of which India has to complain.

One of the first things that strikes an impartial student of the literature of this question is the apparently excessive prominence given to the official aspect of the case. This is due partly to the overwhelming preponderance of the official element in India, which swamps all private interests and opinions, and partly to the singular ability with which the skilled servants of the Crown in that country have handled the extremely difficult problems arising from the disturbance, since 1873, of the old and accepted standard of valuation for the precious metals. There is a general agreement of opinion as to the merits of the comprehensive State paper by Mr. R. B. Chapman, the late Financial Secretary to the Government of India, which was submitted to the International Monetary Conference at Paris last year, and which, according to Mr. Cotterell Tupp, of the Bengal Civil Service, who has published an excellent translation of the *Procès verbaux* of the Commission, is pronounced by such high authorities as M. Cernuschi, Sir Louis Mallet, and M. de Lavelaye, to be "one of the ablest expositions of the bi-metallic theory which has yet been written." Sir Louis Mallet himself, and Sir John Strachey, are generally recognised as the chief representatives, along with Mr. Chapman, of Indian opinion on exchange and currency questions; and at Paris no one who attended the Conference of 1881 seems to have doubted that these distinguished officials expressed the views, not merely of their own class, but of all men of business engaged in the Indian trade.

What, then, is the description given by these authorities of the way in which Indian interests have suffered by the depreciation of silver? Mr. Chapman says:—"The yearly loss to India from the recent monetary disturbance has been estimated at about 2½ millions. Large as is that sum, it represents, it is believed, feebly and inadequately, the injury inflicted upon British India by the loss of general confidence in the stability of its standard measure of value." And, referring elsewhere in his paper specifically to the inconvenience caused to trade by fluctuations of exchange, he declares that the apprehensions springing from the uncertainty thus produced in mercantile calculations "are often sufficient to paralyse trade." Sir John Strachey, in the recently published work in which he has given us the fruits of his vast Indian experience, admits, on the other hand, that "there is hardly room to doubt that the foreign trade of India has been stimulated by the increase in the value of gold which has almost certainly accompanied the depreciation of silver where that metal has ceased to be coined. There is at present no evidence that the purchasing power of the rupee in India has been injuriously affected, and it is reasonable to suppose that, under the actual conditions of Indian trade, its volume has been increased by the increase of the silver value of the gold employed in the foreign trade. Approximately, this increase of value will be represented by the loss of exchange on the remittances required to settle the trade accounts of India, and may therefore be reckoned at £2,500,000 or £3,000,000 sterling. Contrary to what is taught by economists, there is no evidence, from the returns, of any special improvement of the exports as compared with the imports, and it is therefore probable that the import and export trades are to so great an extent interdependent, that the advantage is distributed between them. If this view be correct, the trade of India at the present time may be regarded as being carried on with the stimulus of a bounty of some £3,000,000 yearly, or about 2½ per cent. on its total value, supplied by general taxation, and rendered necessary by the currency of India being based on a silver instead of a gold standard. . . . . The export trade is therefore increased by this amount at the cost of the general revenues. Should any change of circumstances arise by which the exchange value of the rupee were raised to its old amount, the revenues would gain by the amount of the present loss by exchange, to the disadvantage of the traders." Sir Louis Mallet, in the out-spoken declaration in favour of bi-metallism which he made before the Conference of 1881, contended that the present state of things is as hurtful to Indian trade as to the finances of the Indian Government. After enumerating the losses of the State, he goes on to say, "Lastly, there is the loss which is sustained by trade. During the last few years, I have had too many proofs that the interests of trade have been seriously affected and injured, in consequence of the depreciation of silver, to doubt the reality of the losses incurred. It is no doubt true, that when trade has been able to adapt itself to an alteration in the relative value of the standards of the two countries, if their alteration was of a permanent character, and took place once for all, the evil would cease. But this is not the case. The future is as uncertain as the present in the existing state of things; and it is this uncertanity which impedes and prevents trade." Can we wonder that an authoritative statement of this kind was regarded by the Conference as conclusive evidence of the accuracy of a speech made by M. Cernuschi at a previous meeting, in which he had said:—"Indian commerce suffers as well as the Indian Government. We must not, therefore, be astonished at the cries of distress which come from India. The complaints of that country are echoed in England—the Chambers of Commerce, the Manchester, Liverpool, Birmingham, Glasgow, and London merchants, the great oriental banks, and all these clients appointed from India, are becoming partisans of bi-metallism."

Well, it seems to me that our first object in this controversy should be to search out facts, and scrupulously to avoid the use of any language that savours of exaggeration; and I have, therefore, tried to discover what ground there can be for these distressing accounts of the state of helplessness and misery to which India has been reduced. Now, all the inquiries I have been able to make have led me to the conclusion, that India is by no means in such a condition as to demand our pity. Lord Lytton justly boasted at Manchester, the other day, that the re-organisation of the finances effected during his administration has left at the disposal of his successor a yearly surplus of several millions sterling, which is available for completing the abolition of customs duties on imported goods, and making the immense Indian Empire one free and open market for the sale of English merchandise; and Sir John Strachey, at the close of a detailed review of the financial situation, in like manner remarks:—"There remains, at the present time, after providing for famine and all other liabilities, excepting always any further possible charge under loss by exchange, an available surplus of at least £2,000,000." Mr. R. B. Chapman, in his interesting letter to Professor Nasse, speaks even more hopefully. He lays down as indisputable these propositions:—"(1) That, after the most rigid exclusion of all items which do not properly belong to those years, the revenues of the two years, 1879-80, and 1880-81, have exceeded the public expenditure, with the exception of the expenditure on war and famine, by no less than 4½ millions sterling a-year; (2) that the revenues of India, so often stigmatised as inelastic, have grown during the last twelve years by no less than 9 millions sterling a year, and present every appearance of a further healthy development; (3) that the public expenditure during the same period has increased by only 3¼ millions, of which 2¾ millions is due to the (by the Government of India) uncontrollable accident of the disturbance of the relations between gold and silver; (4) that the public expenditure presents no appearance of further development to correspond with the prospect of the growth of the revenue; (5) that there is no true foundation whatever for the common prejudice that the people of India are heavily taxed." Mr. Chapman might have added that the credit of the Government of India has of late years steadily improved, so much so that the average rate of interest on the debt has been reduced from 4·6 in 1869-70 to 3·8 in 1880-81.

The Indian treasury is clearly, therefore, not in a very bad way, after all. No doubt, it would have been placed in even better circumstances if it could have saved the two or three millions a year it has been losing since 1876 on its remittances to England; but, on the other hand, it is only fair to point out that the growth of the Indian revenue during the same period, which gladdens Mr. Chapman's heart, is largely due, as he admits, to the increased productiveness of the land tax, the excise, stamps and registration, and to the steady improvement in the earnings of the railways. These, however, are the branches of revenue which are most quickly influenced by the state of trade; and their flourishing condition ought to have suggested to Indian officials a doubt whether the depreciation of silver, of which they complain so loudly, has not really proved to India a blessing in disguise by stimulating both the home and the foreign trade of the country to a degree of unprecedented activity.

If we consult the pages of the latest Statistical Abstract for British India, we shall find ample evidence to strengthen the impression that, considered from the commercial point of view, the fall in silver can certainly not be held to have done any harm to Indian interests. I need hardly remind you that a marked feature of the external commerce of India is the much-debated excess of exports over imports. This arises from the obligation under which India is placed, to remit year by year to England about 18 millions sterling* in payment of what are known as the home charges. The process of remittance is managed in this way. The Secretary of State for India draws bills on the treasuries at Calcutta and Bombay, and these are bought by the exchange banks, and sent out to India to pay the shippers of an equivalent amount of produce. Virtually, therefore, India gets no return in imports for 18 millions' worth of her exports, which are paid for in India by the Government; and it may be said with truth that India liquidates the interest on her debt, the dividends on railway capital, and other home charges, by remitting to this country merchandise valued at 18 millions. Sir John Strachey is naturally indignant with the perverse critics who quote his admission that for this excess of imports there is "no commercial return," as if he had meant to say that "the transaction was without proper consideration;" and he shows clearly enough that the excess only represents payments for value received in labour and capital lent to India. But I am surprised that he should have overlooked one most important qualification of the statement, that there is no set-off in kind, no commercial return, for the exportation of so much Indian merchandise. Against the drain on India constituted by the home charges we must place the gain to the Indian treasury from the opium revenue. If English rule is responsible for compelling the people of India to pay this country 18 millions a year, it must also be credited with recovering for India eight millions of that amount from the Chinese. In point of fact, the Indian Government is able to discharge nearly half its annual liabilities to the Secretary of State by drafts on China. When the drafts of the Secretary of State mature for payment in India, the Government has already in hand eight millions in cash, the amount of the opium revenue, which is available towards meeting them. Now, this amount is paid, in the first instance, to the Indian Government by the native dealers, who in their turn export the opium to China, and include the duty in their drafts on that country. Opium, therefore, figures in the returns of exports of merchandise from India as worth, in the year 1880, for instance, as much as £14,323,000, though, from what I have said, it will be obvious to you that the actual value of this merchandise to the Indian producer is only about six millions, and that the remaining eight millions is merely the duty, by which its value is artificially enhanced, and which is ultimately collected from the Chinese consumer. Strictly speaking, then, if we wish to strike the balance of India's foreign trade, we ought to deduct the amount of the opium revenue from the nominal value of the exports of merchandise; and, if we make this modification in the figures for 1880-81, we get the following results:—

Exports—	
Merchandise	£66,540,000
Treasure	1,440,000
Total	£67,980,000
Imports—	
Merchandise	53,100,000
Treasure	8,990,300
Total	£62,090,000
Net excess of exports ..	5,890,000

The gratifying inference from these statistics is, that India gets back in imported goods and treasure the value, to within six millions, of her exports, or more than nine-tenths of what they are really worth; that is to say, the profits of her foreign trade are so great, that although the total amount she has to pay abroad every year in the shape of public and private remittances, freight, commission, and other charges, can hardly be estimated at less than 25 millions, the net loss to the country through the discharge of all these liabilities is reduced to six millions.

Having thus cleared away a popular misconception as to the actual state of Indian commerce, I proceed to consider the question, whether the commercial prosperity which undoubtedly exists has been hindered or furthered by the depreciation of silver. In this inquiry, I may take as our starting point the year 1873, in which the action of Germany began to have a marked effect in unsettling the value of the metal which forms the standard of all Indian mercantile transactions. The trade statistics of this period may be thus summarised:—

(The figures are given in millions and decimals of millions sterling, 0,000 being omitted.)

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* This is the valuation at 2s. the rupee, the rate at which the values of exports and imports are taken in the accounts.

Year ending March 31st.	Imports.	Exports.	Excess of Exports.
1873	36·43	56·55	20·12
1874	39·61	56·91	17·30
1875	44·36	57·98	13·62
1876	44·19	60·29	16·10
1877	48·88	65·04	16·16
1878	58·82	67·43	8·61
1879	44·86	64·92	20·06
1880	52·83	69·25	16·42
1881	62·08	75·98	13·90

These figures supply an interesting record of the steady growth of both the import and the export trade during the eight years of a very low rate of exchange for the rupee. The only noteworthy variation is in the year 1879, when the imports of treasure fell far below the usual level, apparently because an abnormally large amount of gold and silver had been imported in 1878. But, taking the period as a whole, we find that, chequered though it was by seasons of famine, it bears the signs of distinct and constant commercial progress. Thus, the increase in the annual value of the exports between 1873 and 1881 was no less than 19·43 millions, or at the rate of 35 per cent. What is still more remarkable, however, when we have regard to the common opinion that the depreciation of silver may have given an impulse to the productive power of India, but must have caused a decline in the consuming power, is the far higher rate of advance in the value of the imports, which increased in the eight years by 25·65 millions, or just 70 per cent. In not one of the eight years subsequent to 1873 did the net excess of exports reach the high figure of that year or of 1872; in 1879, owing to a peculiarity already explained, it was as much as 20·06 millions, but this enhancement was counter-balanced by the exceptionally low rate of 8·61 to which it fell in 1878. During the whole period the excess was gradually reduced, till in 1881 it was only 13·90, and in this sum the opium revenue is of course included.

The statistics for the current year are not yet completed, but it may reasonably be expected that the volume of trade will greatly surpass that of 1881, which in its turn exceeded by many millions sterling that of any previous year. I subjoin a comparison of the figures for the eight months up to the end of November last with those of the corresponding period of 1880:—

	Eight months, 1st April to 30th November. 1880.	1881.
Imports:	£	£
Merchandise	33,944,239	32,669,245
Treasure	6,477,798	5,835,755
	£40,422,037	38,505,000
Exports:—		
Merchandise	44,318,206	48,180,111
Treasure	1,063,996	835,373
	£45,382,202	£49,015,484

The exports, therefore, increased by nearly four millions, while there was a decrease in the imports of two millions, leaving a large amount due to India to be made up before the end of next month, when the financial year 1881-82 comes to an end.

The remaining months of the year will make the comparison even more favourable for 1881-82; for never since the opening of the Suez Canal has the Indian trade been brisker than during the last three or four months. From all parts of the country we hear the same good tidings of prosperity. In all branches of commerce unwonted activity reigns; but it is in the exportation of wheat, in particular, that progress, which may well be described as marvellous, has been made. Bombay alone, during the calendar year 1881, exported 9,400,000 cwts. of wheat, worth, probably, 4½ millions sterling; and this is eight or nine times the quantity shipped from all India in any year before 1880, and twice as much as was shipped in that year. It is possible that the imports may not respond immediately with corresponding growth to this amazing development of the exports; but it should be remembered that the operations of trade have a self-adjusting power, within certain limits, on the exchanges, and that the recent marked rise in the exchangeable value of the rupee, which has been the natural result of the enlargement of India's export trade, has caused a considerable amount of silver to be remitted to India, and has also made dealings in imports of merchandise more profitable, and that it so tends, by increasing shipments from other countries, to bring down exchange again. Thus, we may fairly count upon a repetition of the experience of the last two or three years, which has shown us that the fortunes of the export and import trades are closely interwoven with one another, and that India gets better value every year for the produce she sells to the foreign consumer.

But what share has the depreciation of silver had in bringing about this result? I believe myself that it would be difficult to over-estimate its influence in improving the trade of India. A gentleman who has had many years' practical experience in the management of mercantile business at Bombay, and who was lately chairman of the chamber of commerce of that city, Mr. Magnus Mowat, wrote to me the other day:—"But for the low sterling value which the rupee has touched, I doubt if we should have seen the great development in the export trade which has lately taken place. Take wheat, for instance. At the present rate of exchange, about 1s. 8d., I can pay the Indian producer Rs. 30 per candy for No. 1 white wheat, after making allowance for freight, commission, and other charges; but if I had to sell my bills at 1s. 10d., I could not afford to pay him more than Rs. 27¼. The difference might in many cases stop business. The same holds good with cotton, linseed, and other articles which are exported from India." This is the view held, I may say, by every one engaged in the Indian trade, and it is obviously the only one consistent with the facts of the case. But for the low rate of exchange, then, we should never, in all probability, have had opened out to us the fair prospect of effective Indian competition with America for the supply of wheat to the English market. In this respect, at least, the fall in the value of silver appears to have done good service to England as well as to India.

Sir John Strachey assumes, as we have already seen, that the gain on this increased volume of exports is measured by the £3,000,000 which the Government of India loses, and that this sum is practically a bounty paid out of the general revenues of the country to the trading class. If these propositions were well-founded, we might readily acquiesce in the opinion that the increase of trade has been only a barren gift to India. But Sir John Strachey seems to forget that the special profit due to this cause is made on the whole amount of the exports, and not merely on a proportion equivalent to the Secretary of State's drafts. If, then, we take the difference between exchange at 1s. 8d. and exchange at 1s. 10d. as worth about 8 per cent., and calculate this per-centage on the total exports of merchandise, which in 1880-81 were valued at 74·54 millions, we get a clear gain to India of close upon six millions, or double Sir John Strachey's estimate. Again, it is inaccurate to say that this sum is appropriated by the traders, who in India certainly do not at present pay their fair share of taxation. Most of it goes into the pockets of the producers, who are also the principal taxpayers, for it is notorious that, in these days of general enlightenment, the ryot who has cotton or wheat to sell is as well-informed as the Bombay merchant about the market prices in Europe, and that he is quite competent to drive a hard bargain, and to reduce to a minimum the charges of the middleman with whom he has to deal. It follows that whatever loss by exchange the general revenue suffers on the annual remittances to England is probably repaid twofold to the very men from whom that revenue is collected, that is to say, to the agricultural population on whom the land-tax is levied, and who are the principal consumers of salt.

But, if the increase of profits on the seaborne trade had been counterbalanced by a simultaneous rise in the prices of commodities used in the internal trade of the country, in consequence of a falling-off in the purchasing power of the rupee, we might be puzzled to say whether the interests of India had gained or lost, on the whole, by the depreciation of silver. All authorities, however, are at one on this point, that only the international value of the rupee has been affected, and that its value, as measured by the quantity of the common food of the people which it will exchange for in India, remains as high as it was ten years ago. This phenomenon contradicts all the received opinions of economists as to what ought to have happened, and no adequate explanation of it has yet been offered. May I hazard a suggestion of my own as to how it may be accounted for?

By a curious, and, some persons might say, a providential coincidence, the great change which took place eight years ago in the value of silver in Europe was contemporaneous with the accomplishment of a revolution in the ways of internal commerce and social life in India. It was in the year 1873 that the through railways from Bombay to Calcutta and Madras were completed, and that the people of India entered into the enjoyment of the fruits of years of labour, designed to place at their command the most admirable gifts of western civilisation. From that year may be dated the full appreciation by the natives of all the trading and personal advantages which this new system of communication between distant parts of the country placed at their command, and, with every fresh hundred miles of railway that have since been opened, the population of some districts previously out of reach has been aroused to take a keen interest in a world beyond the limits of its own and the neighbouring villages. The transformation thus wrought in India is nothing short of magical; it may be compared to the change which the first breath of spring after a hard winter makes in the face of all animated nature; or rather, perhaps, the touch of science has been the kiss of the fairy prince, awakening India to a fuller knowledge and a larger life, after a sleep that has lasted not a hundred years only, but many ages. Every one who has lived in India of late years must be conscious of the difference, which seems to be felt in the very air. The country has, as it were, been quickened with a new and more vigorous vitality; the blood, which used to move so sluggishly, now circulates freely and strongly through all her veins; trade flows through a thousand channels to far-off markets, where the grain that used to rot on the ground for the want of purchasers can now be profitably sold; and the money thus acquired may be spent in the gratification of all those new tastes which the freer social intercourse, resulting from the greatly increased facilities of travelling, everywhere creates. But to supply the wants of this more animated life, this much brisker course of trade, a far larger quantity of silver coin, which forms the currency of India, is required than sufficed for the needs of the simpler age before the introduction of railways. Mr. Pedder, some time ago, drew attention to the greater amount of work the silver currency has to do, now that the opening out of the country has brought it into general use, and made it supplant the cowrie currency and the rough system of barter that prevailed in rural districts; but the enormous development of trade that has taken place everywhere in India is still more largely accountable for the increased employment given to the rupee. Had circumstances prevented a free importation of silver into India during the last eight years, money must rapidly have grown scarce and dear, and the prices of all commodities would have fallen. But, fortunately for the progress of the country, silver has been during this period unusually abundant and cheap, owing to the anxiety of the European nations which have demonetized it to sell it at any price they could get for it; and India has availed herself to the full of the opportunity thus presented to her. My theory as to the necessity imposed upon her to replenish her currency is borne out by an examination of the quantities of silver money coined at the Indian mints of late years, as shown by the following table:—

	Four years, 1868-9 to 1871-2.	Four years, 1872-3 to 1875-6.	Four years, 1876-7 to 1879-80.	1880-1.
	£	£	£	£
Net imports of gold	16,598,934	7,344,667	[*]1,529,810	3,664,199
Coinage of gold...	123,221	78,477	30,450	13,354
Excess of imports	16,475,713	7,266,190	1,499,360	3,650,845
Net imports of silver	23,395,672	9,408,525	33,715,643	3,892,574
Coinage of silver	15,089,182	13,798,022	39,919,185	4,249,676
Excess of imports	8,306,490	...	...	...
Excess of coinage	...	4,389,497	6,203,542	357,102
Total (gold and silver)—				
Excess of imports	24,782,203	2,876,693	...	3,293,743
Excess of coinage	...	...	4,704,182	...

It will be seen from this table that, during the nine years, 1872-73 to 1880-81, the demand for an increase of the silver currency was so great that the coinage exceeded the imports by nearly 11 millions, although the quantity imported amounted to 47 millions. In the four years preceding 1872-73, a different state of things prevailed, as the imports exceeded the coinage by more than eight millions. It appears, therefore, that India has not only coined of late years all the silver she could get from abroad, but has also drawn largely upon the hoards of the metal accumulated in previous years. The briskness imparted to the circulation of rupees is especially noticeable in the returns for the four years, 1875-6 to 1879-80, in which the mints coined the enormous amount of forty millions sterling, or at the rate of ten millions a year, the old average having been from three to four millions. It is also significant that, during these four years, the importation of gold was almost discontinued, in consequence, partly, of the urgent need for silver, and partly of the fluctuations in exchange. These fluctuations had no effect in lowering silver in public estimation; the rupee still remained the standard of value; but gold, which is only bought as an article of luxury, fell temporarily out of favour, because its value, as measured in rupees, was subjected, by the frequent variations in exchange, to violent and apparently capricious alterations. In 1879, exchange became steadier again, at or about the level of 1s. 8d., and, accordingly, gold has again been in great demand for India, the imports in 1880-81 having amounted to £3,664,199, and in only eight months of the current year to nearly the same amount, or £3,220,000, of which the large proportion of £920,000 was shipped directly from Australia to India. The coinage of silver fell in 1880-81 to a little over four millions, showing that the supply was beginning to overtake the demand for rupees, but there was again an excess of coinage over imports. In the eight months of the current year, for which we have complete returns, the net imports of silver were only £1,781,180 against £3,000,000 in the corresponding period of 1880; and of this amount only £651,931 was coined into rupees. This falling off in the imports up to the end of November, accounts for the extraordinary demand for silver which set in last December, and is still maintained, and which, by sweeping the market bare of supplies, keeps the rate of exchange at an unusually high level.

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[*] The net import of gold during 1879-80 was £1,750,504; in the other three years of the series there was either an insignificant importation or an excess of exports.

N.B.—I have been permitted to copy this table from a departmental paper prepared at the India-office.

What has happened, in fact, in India with regard to silver, is precisely analogous to that which took place in Europe with regard to gold, after the discoveries of immense gold fields in California and Australia. We know that at that time great alarm prevailed as to the probable effect of the new supplies in lowering the value of gold; and a great French economist actually proposed that this metal should be demonetised. But it was soon found that the enormously accelerated movement given by mechanical science to modern industry and commerce required for its successful working a much ampler currency than that which served all the purposes of trade in less energetic times, and that all the gold that Australia and America could produce might be passed into circulation without disturbing the monetary value of that metal. In like manner, the material revolution which has taken place in India, and the marvellous expansion of her home and foreign trade, have enabled her to pass into her currency system a largely increased supply of silver coin, without feeling any ill effects from this addition to the circulation. Rather, the change has done good to the whole country; and, as I have already incidentally remarked, the revenue of the State has benefited indirectly by the general prosperity of the people. If it be the case that the total annual charge for the productive works and debt taken together has been reduced during the last 13 years by £3,500,000, in great measure through the rapid development of the railway traffic, and if, at the same time, there has been a steady increase in the revenue yielded by duties on articles of general consumption, then it is incontestable that even the Indian treasury has something substantial in the way of gain from the depreciation of silver to set against the loss by exchange on the remittances to England.

But are there, then, no Indian interests which have been injured by monetary changes which may, perhaps, have been beneficial to the country at large? Undoubtedly, it is the case that during the earlier years of the period of depreciation, while the fluctuations in exchange were many and violent, serious losses were incurred by the English mercantile firms which have capital invested in India. It is to those years that the memorial belongs which was submitted to the Government of India by the Bengal Chamber of Commerce in favour of a suppression of the coinage of rupees at the mints of Calcutta and Bombay. But that memorial has not been followed by further remonstrances in the same direction on the part of any of the Indian chambers of commerce; and during the last three years, at all events, there have been no complaints from the mercantile community of India as to the effects of what the Government persistently speaks of as a great financial calamity. The truth is, since the German Government ceased selling silver, the much-desired stability in the exchanges has been attained. In the financial years, 1879, 1880, and 1881, the Secretary of State's drafts were sold at averages of 1s. 7·794d., 1s. 7·961d., and 1s. 7·956d., rates which show a very close approach to uniformity; and, during the current financial year, it is probable that the curve of variations will be very slight indeed, except for the last two or three months, for the chart issued by Messrs. Page and Gwyther, for the calendar year 1881, gives a remarkably steady rate of exchange, within limits of 1s. 7$\frac{7}{16}$d. and 1s. 8$\frac{1}{16}$d. for the whole year. Business has, consequently, adapted itself to the lower range of values on which silver has now settled down, and it is carried on as profitably as when exchange was at 1s. 10d. English officials, however, in India, whose salaries were fixed on the basis of a much higher rate of exchange than now prevails, have an undeniable grievance in the effect upon their fortunes of the altered state of things. These gentlemen have large remittances to make to England for the support of their families and the education of their children, and the prices of luxuries imported from this country into India for the daily use of Englishmen, such as wines, carriages, books, glass, china, table delicacies, and so on, have all been raised by the Anglo-Indian tradesmen in the proportion of loss by exchange; so that, according to Mr. Cotterell Tupp's calculation, a judge or collector on Rs. 2,000 a month, who should have £2,400 a year in gold, now loses at the very least one-eighth of his income. These servants of the Crown had a distinct bargain with their employer, and they have a fair claim to compensation. But they ought not to be compensated at the expense of the general interest of the country. If the depreciation of silver has made India prosperous, they have no right to ask that either a gold coinage or bi-metallism shall be introduced for their special benefit. The proper course to pursue would be to inquire fully into their claim; and, if it be proved that their pecuniary position is not so good as they might justly have expected it should be, to grant them that compensation, in the form of an increase of their salaries, which the country, to whose advancement they have fallen victims, can well afford to give.

But the gain which accrues to India from the depreciation of silver, since it is the fruit, not of a natural development of commerce, but of violent changes made in the currency of certain European States, means, in all probability, an equivalent loss to the nations which deal with India; and a close examination of the trade returns would seem to show that this is the case. If we take, for instance, cotton manufactures, which form by far the most important article of English merchandise shipped to India, we find that the quantities have increased during the period of the excessive depression of silver, but that there has been an actual, though slight, falling off in the value. Hence it is evident that the people of India must be paying much less now than they did eight years ago for the clothing they buy from England, as they pay for the goods in rupees, of which it now takes twelve, instead of only ten or eleven, to make a sovereign. This rule is applicable to the whole of the English trade with India, and it enables one to understand why that trade has been for many years so unprofitable to English shippers and manufacturers. A mercantile friend of mine contends that a low rate of exchange for the rupee is not even unfavourable to England. He says:—"Now that exchange is keeping pretty steady, and that a low level has been reached, Manchester goes on as usual. There has been more outcry than there was any occasion for. The greater part of the Indian business is now done by sterling indents, the risk of exchange being taken by the native dealers in India. They never dream of getting 2s. for the rupee, but retail their goods in the Mofussil markets on the basis of current rates. Of course, if any Manchester speculator sends out a consignment of goods to the East, he must just take his chance of results; but this sort of business is not done now to the extent it was in the time of the Collies and Heugh Balfour and Co." I am afraid, however, that this pleasant theory will not hold water. The native dealer may nominally take the risk of exchange, but he will be very careful to allow a wide margin for it in bargaining with his English correspondents; and the anxiety of English manufacturers to find markets for their goods is now so keen, that they keep India almost constantly overstocked, so that they have, in most cases, to bear the burden of both the import duties and the loss by exchange. It is, therefore, a sound instinct which has prompted so many influential firms in London, Liverpool, and Manchester, who have business relations with the East, to urge upon the Government the expediency of adopting the principles of bi-metallism; while, on the other hand, if the survey I have given of the state of things in India is accurate, we need feel no surprise at the significant silence maintained by purely Indian interests as to the wrongs they are alleged to have suffered through the depreciation of silver.

It remains to consider what turn the silver question is likely to take in the immediate future. I am not going to prophesy. He was a wise man who said with regard to politics, "But what is going to happen I know no more than the prophets do," and that prudent observation is equally applicable to matters of finance. But it is possible, without indulging in speculation, to look forward, with some confidence, to the preservation of that stability in exchange which now exists, unless, by the sudden and capricious action of Germany, France, or America, the market should be again flooded with demonetised silver. A year ago, Mr. R. B. Chapman maintained that India's capacity for absorbing silver depended entirely on the growth of her debt in England, which has lessened *pro tanto* the amount of the Secretary of State's bills, and compelled merchants to make remittances in specie; and he argued that, when this system of borrowing came to an end, as it must soon do, India would cease to be the medium for relieving the rest of the world of its superfluous stock of silver. But the declared policy of the Government of India is to go on constructing public works with borrowed money, and to employ surplus revenue in the reduction of taxation, and in this way their action will strengthen exchange. Moreover, Mr. Chapman seems to have underrated the possible extent of the development of India's foreign commerce, and to have forgotten that the exports must always be largely paid for in silver, as the people of India produce nearly everything they want for themselves, and will never import as much merchandise as they supply to foreign nations. Certainly, the recent course of trade has not justified Mr. Chapman's fears. On the contrary, the demand for money in India has steadily grown stronger, and during the last two months we have seen exchange ranging above 1s. 8d., with a tendency to go even higher. It seems, then, by no means a rash assumption that, given a continuance of good harvests in India, the activity of that country's export trade will suffice to keep exchange at the level of 1s. 8d., subject only to such slight fluctuations as are the natural ebb and flow of the tide of commerce.

But, since the failure of the Paris Conference of last year to secure an international agreement, fixing the relative value of gold and silver. threats have been uttered by the friends of bi-metallism on the other side of the Atlantic that the United States will embarrass India by stopping their coinage of silver, and so violently disturbing once more the price of that metal. Those threats seem to me to be very injudicious. Not that there is much force in the reply to them made on behalf of India, that she could retaliate by demonetising silver herself, and so making it absolutely worthless. Sir John Strachey is the principal advocate for the introduction of a gold currency into India; and he points out that there is plenty of gold available in the country for purposes of coinage, as the net imports in forty-six years have amounted to nearly £108,000,000. No doubt this is a strong argument in favour of the practicability of bi-metallism, which would bring into active circulation a large proportion of the gold now hoarded uselessly in India. But the present Viceroy of India, differing in opinion on this subject with most of his colleagues, has set his face against bi-metallism as unsound in principle; and, this being so, it would be simple madness to attempt to substitute a single gold for a single silver standard in India, and to discard the use of silver in the currency altogether. I have endeavoured to prove to you that, so far, India has every reason to be satisfied with her present currency; and, if western nations choose to proceed still further in their suicidal course of rejecting the use of silver money, some of her interests may be temporarily injured, but in the end she will not be a loser by the change.

But it is not at all likely that the threats used in the United States will be carried into effect. Every day that passes serves to demonstrate more clearly the wisdom of the conclusion arrived at by the Conference of 1878, at which England was represented by Mr. Goschen, Mr. Gibbs, and Sir T. Seccombe, that "it is necessary to maintain in the world the monetary functions of silver as well as gold." The growth of the feeling in favour of the rehabilitation of silver was plainly marked in the discussion at the Conference of 1881; and recent financial troubles have still further strengthened the hands of the bi-metallists, by making clearly manifest the scantiness of the stock of gold now in circulation, and the perils to which European nations are exposed in their desperate struggles to secure the lion's share of it.

England has, up to this time, been distinguished as the most determined upholder of the single gold standard. Our financiers have taken a high, not to say arrogant and somewhat purse-proud, tone in rejecting with scorn the humble petitions of other nations that this country would condescend to reconsider her monetary system, and admit at least a doubt of its perfection. The short answer invariably given to such appeals has been, that England was quite content with her single gold standard, and if other nations, not so rich as she, had discovered that they had acted foolishly in imagining they could live up to her standard and employ gold only in their currency, that was their misfortune, and it was open to them to return to their former habits, and resume the use of their discredited silver money whenever they thought fit to do so. This attitude of proud isolation was all very well so long as the unrivalled wealth and commercial superiority of England gave her the complete command of the money market, and enabled her at all times to procure as large a supply of gold as she required. In such circumstances the Bank of England could at any time replenish its stock of gold by raising its rate, with all the ease of an accomplished musician playing on the piano, or of an engineer setting in motion the mechanism of a hydraulic dock. A distinguished monometallist admitted, after the adjournment of the Paris Conference of 1881, that the time might perhaps come when England would find she had not gold enough for her wants; but, he cheerfully added, she could then fall back on silver. That struck me as a singularly careless remark; for a skilful captain does not usually wait till his ship is among the breakers before making preparations to weather the storm. Signs are not wanting that the contingency which, a few months ago, seemed so distant that it might be lightly spoken of is already at hand, and that the storm will soon burst upon us. Gold seems to be losing the stability which silver has regained, because the scramble for it among nations possessed by the gold monomania, exposes its value to such rude shocks and constant fluctuations, that merchants cannot tell what the rate of interest on money will be from one week to another. The peculiar feature of the monetary crisis, from the effects of which this country is still suffering, is that it has not been brought on by over-trading. Business has of late years been conducted in England with the utmost caution, as befitted an era of low prices and small profits, and there is no question as to the soundness of trade in all its branches. All the more vexatious is it that our reviving commerce should be checked by dearness of money which is due to no other cause than the feverish competition for gold among the gold currency States of Europe and America. This struggle for existence is so keen, that the Bank of England can no longer keep gold from flowing out of its coffers to Paris, Berlin, and New York. Without raising the vexed question whether England is growing richer or poorer, I may be permitted to draw attention to the following statistics of gold imports and exports for the last five years, which show that a drain of gold from this country has set in, and is steadily assuming larger and more alarming dimensions:—

	Imports.	Exports.
1877	£15,441,985	£20,361,386
1878	20,871,410	14,968,507
1879	13,368,675	17,578,818
1880	9,454,861	11,828,822
1881	10,000,000	15,500,000

Now, it is essential to the security of our monetary system that we should steadily import more gold than we export; yet during the last three years we have lost on balance eleven millions sterling. This continuous decline in the amount of gold held in this country is a novel and startling phenomenon, yet it has hitherto attracted little or no attention. The reserve of the Bank of England, which forms the main support of that great fabric of commercial credit of which we are all so proud, has, under the influence of optimist counsels, been allowed to fall so low that, when the collapse of speculation on the Paris Stock Exchange compelled French capitalists to realise all the securities they held in this country, and take the money away, the directors of the bank were left with less than ten millions sterling to supply the wants of the mercantile community; and they soon found that they could not at once replenish their stock by simply raising the rate of discount 1 or 2 per cent. Paris and Berlin, which wanted gold as badly as London, were ready to bid higher terms than the Bank of England offered; and America, besides being a long way off, had very little gold to spare, nor were there any visible supplies afloat on their way to England. Even when the much desired increase in the reserve has at last been attained, it is held only by a precarious tenure. London used to be the the central gold market of the world; all the supplies of the metal produced in America and Australia were sent first of all to this city for sale. Now, America consumes all her own gold, and imports supplies directly from Australia, and, as we have seen, direct shipments are also sent from the Australian gold fields to India. Hence, the Bank of England can only get gold by outbidding other gold currency States; and the directors are kept in a constant state of nervous anxiety, with one eye fixed upon New York and the other on Paris, and the greatest monied institution in the world is reduced to such a pitiable position that it cannot keep a sufficient stock of gold from one week to another without fixing its rates of discount so high as seriously to embarrass the commerce of the country. It is obvious that matters might have been worse, but for the accident that America, owing to the partial failure of her crops last year, has not, at present, such heavy claims upon us as she has in ordinary years. It is improbable that such a state of things can be allowed to continue till all but one of the gold currency States are ruined, and the fittest only survives.

Everyone now admits that the vain attempts of western nations to maintain an exclusive gold currency have had a disastrous effect on commerce, and that they are likely, if not soon abandoned, to cause a permanent reduction in the value of all kinds of property. The only controversy now is, which nation ought to be the first to set the example of going back to the use of silver. English financial critics lecture the Governments of Paris, Amsterdam, and Berlin, on their folly in imagining that they can dispense with silver; while Continental critics, in their turn, exultingly predict that England's commercial dependence on the United States will soon leave her in the same sorry plight into which gold mono-metallism has already plunged the rest of Europe. The fear of being involved in a common destruction must have influence with all the States engaged in this unprofitable wrangle, and induce them to accept a compromise which shall give free play to both gold and silver.

All the symptoms, therefore, are favourable to the rehabilitation of silver, and the speedy triumph of bi-metallism, which alone can extricate Europe from its difficulties. But, whether bi-metallism be adopted or not, India can afford to regard the struggle for gold with equanimity; and, secure in the enjoyment of the prosperity for which she is indebted in great measure to the depreciation of silver, think it sport, possibly, to see "the engineer hoist with his own petard."

DISCUSSION.

Sir **Richard Temple** said, having lately returned from India, and having there witnessed the same circumstances which Mr. Maclean had described, he deemed it right to give his emphatic testimony to the correctness of all he had said with respect to the Indian trade. He had examined this question carefully, at various periods, especially in the year 1874-5, when the effect of the depreciation of silver began to be felt, and it was then thoroughly understood by all the best authorities in India, that this depreciation was beneficial to the Indian export trade, though it was very oppressive to the Government, and to the European community, and was on the whole much disliked by all the exchange banks, so that a great deal was heard about it in the public press. At the same time, it was understood by the natives to be, on the whole good for them, and especially those interested in the export trade of British India. Whether it was actually good for the import trade was not so certain, but being good for the export trade, it was, on the whole, good for India at large. With regard to the question of bi-metallism, he was not sure that he was not one of the mono-metallic school; but he gathered from the applause with which Mr. Maclean's remarks were received, that many gentlemen present were bi-metallists. He certainly, and many others, had always been of opinion that the principle upon which the metallic currency was based, in England, was also applicable to India. By the mono-metallic principle, he understood that there should be a single standard, namely, gold; and that silver should be subsidiary to that, as it was in England. That seemed to him to be a reasonable system; it was adopted in this country and did not seem likely to be altered; and many were of opinion that the best thing possible for India was that she should have the same system as England itself. Though the extreme cheapness in silver was, on the whole, beneficial to the export trade of India, this uncertainty and instability in the basis on which the metallic currency was founded had many grave inconveniences. In the first place, it was a serious thing that it proved so detrimental to the European community; and it operated in this way. In respect to all that they had to spend in the country it made no difference, but they all had to remit money for their families in this country, therefore, it could easily be imagined how grave the effect was. Now, any circumstances which proved detrimental to the European community rendered it more difficult for England to obtain able and efficient men; it lowered the value of Indian appointments of all kinds, and made even the liberal salaries paid by Government much less appreciated than they were before. That was of itself a very great disadvantage. Another thing was, that whatever affected the finances of India, greatly affected the cause of public improvement. There was so much less of railway, canal, and other practical improvements carried out, and, therefore this instability of the Indian currency was very much deprecated. It was to be hoped that some day they would have a mono-metallic gold standard in India as there was here. An opportunity for producing such a standard occurred between 1862 and 1865, during the American Civil War, and had the Government of India then been able to act with promptitude, a gold currency might have been introduced; but that opportunity passed away, and now it was extremely difficult even to think of such a thing. In the present state of silver, it would probably become an overwhelmingly expensive operation to make any such attempt, and, therefore, he feared they must go on as they were at present. He concluded by stating that amongst the non-official residents in India, very few had been more distinguished, or more able than Mr. Maclean.

Mr. **Martin Wood**, after alluding to his long continued journalistic collateral connection with Mr. Maclean, said he was glad to find that the divergence of view between himself and the reader of the paper was not so great as it had been in times past, and he agreed substantially with the proposition that the depreciation of silver had been some advantage to India—that it had not been that unmitigated disaster which it had been often represented. Both of them had been sickened almost by going through columns and columns of articles in the public press in which the phrase "depreciated rupee" had been used over and over again, when it must have made scientific economists shudder to find even educated men making that error. It must be understood that the depreciation of any legal tender currency could only come about in one of three ways: either by the fineness or weight being diminished, by its being issued in larger quantities than the actual demand for it, or by its validity as a legal tender being interfered with in some way by the Government. None of these things had happened, and, therefore, it was quite incorrect to say that there was a depreciation of the rupee. It was only when the coins were sent out of India that the metal was found to be worth less than before. He agreed that the reduced cost of silver ought to be an advantage to India, by giving it a currency at a lower rate, so that India would give less produce for it. Thus, there ought to have been a general advance in prices, and accession in prosperity; but, as Mr. Maclean had admitted, there had not been the general advance in prices such as might have been inferred. That was proved very clearly by a series of tables collected by the Bombay Chamber of Commerce in 1875-6. The question arose, how was it that although this cheapness of silver existed, it had not the effects which might have been expected? In considering this question, it was important to recognise all the factors, and there were certain facts which, although referred to in the paper, had not been fully worked out. He referred to the broad fact that with regard to the importation of silver to India, there was this one standing drawback, that its influx was checked by the demand of the Home Government which appeared in the form of the Secretary of State's Bills: and he should like to indicate, in what directions, those who wished to go into the subject should follow up this inquiry. One of the principal causes of the depreciation of silver had been the increase on those Bills, which occurred just at the time when silver became more plentiful, in 1873. It was just at that period that the railways in India obtained a certain completeness and development, although not so much as the somewhat rhetorical terms used by Mr. Maclean would seem to indicate. In the three years, 1872 to 1875, the treasure imported into India was only 13¾ millions, whereas in the three years previous, the amount was 26¼ millions. That there was a connection between that and the home demand, is shown by the fact that the Secretary of State's Bills in 1872 to 1875 were 38 millions, whereas in the earlier period there were only 19 millions. During the earlier period the guaranteed railway companies were still paying in a large amount of capital, which *pro tanto* lessened the Secretary of State's demands. In the earlier period these railway companies paid in 8¾ millions, whereas in the later period the amount was only 1½ millions. Then again, from 1868 to 1871 the loans taken up on Indian account in England amounted to 8 millions, but in the later period, from 1872 to 1875, to only 6 millions. The influence of this pressure, since 1873, of Council Bills upon the depreciation of silver generally, apart from its effect on India, was pointed out in the most emphatic manner by the report of Mr. Goschen's Silver Committee in 1876, to which he would refer those interested in this subject. [Here Mr. Wood quoted from the committee's report, thus—"It will be seen that, though the total amount of treasure and bills together, remitted to India during the last four years, has but slightly declined, the proportion between the two has been entirely reversed, as the following figures show, namely: between 1868-9 and 1871-2 there was sent to India 40 millions of treasure and 29½ millions of Government Bills; whereas, between 1872-3 and 1875-6 only 16½ millions of treasure went to India, but the Government Bills amounted to 50½ millions."] In discussing the monetary affairs of India, and of the industrial interests arising from them, English economists were too much in the habit of treating the matter from book, and theorising from formal principles; but it was useless to approach this subject without remembering that the position of India in these matters was entirely different from that of any other country in the world, or any other case in history. When people assumed a balance of trade in favour of India—always an erroneous phrase—they forget that that balance was never made up. Hence the position of India was entirely different from that of any other country. Its case was not provided for in the books, with one notable exception. He referred to the concluding portion of John Stuart Mill's chapter on the "Depreciation of the Precious Metals," where he referred to a case of a country which had to send remittances to a foreign State, either as tribute, or to absentee landlords; but, though Mr. Mill had the facts with regard to India, before him he did not use them to illustrate his proposition. At the time he wrote that, transfer of wealth was not nearly so formidable as it was now, and it was then disguised by the large payments commenced by the railway companies. This passage, however, had been applied to the recent circumstances, especially to the large increase in Government Bills, in a treatise on the subject, written by Mr. Hollingberry, well known to Sir Richard Temple as one of the old servants of the Government of India, in the Finance department. Having seen most of what had been published on the subject, of late years, he (Mr. Wood) must say that this treatise was, perhaps, the most remarkable, especially considering that it was written and printed before the Report of Mr. Goschen's Committee was issued. The facts necessary to be compared, in order fully to understand this question, were these—the amount of the Secretary of State's drafts; the relation between the export and the imports of India; the amount of debt raised in England, including payments by railways; and the Government stock which was sent from India to England, or returned thither. He had intended to make some remarks on Mr. Maclean's argument that opium was a set-off to the loss by exchange; but he would only say that it was an illegitimate comparison in every respect. No doubt the stability of the opium revenue was, in great measure, due to the masterful manner in which India was managed under British rule; but that was only one gain amongst the rest, and had no relation whatever to the depreciation of silver.

Mr. ROBERT MANUEL said his acquaintance with the currency question was not specially connected with India, but it was a question in which he had taken great interest all his life. He had heard in that room many able discussions and papers on the subject, especially from one gentleman, whose loss was lamented in the paper, and a more distinguished bi-metallist it was impossible to conceive. But he had drawn his views on the metallic question from a different source, having been trained by a gentleman who also had read papers from that platform—Professor Leoni Levi, who was an able exponent of the mono-metallic theory. With regard to the special case of India, as far as he understood it, he quite agreed with Mr. Maclean, that India had not suffered to the extent any one unacquainted with the subject might imagine. But he thought that the suffering being limited, was due, not to the incontrovertible fact that a rupee which was current, not only in India, but in England, at 2s. had sunk to the value of 1s. 8d., thus involving a loss of 4d. as an international medium of exchange, but rather to the fact that India had become more enterprising, more enlightened and more productive; and to the extent that this had occurred she had mitigated the effects internally on the loss by exchange. He was very much gratified to find from the paper that the ratio of prices in India had not corresponded with the ratio of the decline in the exchange; but that the Indian ryot got as good value now for his rupee as he used to get when it was worth 2s. The official class in India, the class which had suffered most acutely from decline in the value of the rupee, were paid in rupees nominally worth 2s., but as many of them had their families in England to be educated, they had to remit those rupees in some way to England, where they were only worth 1s. 8d., and to the extent of that difference they ought, if the suggestion made in the paper were adopted, to be compensated by the Government, which he thought would be only right and proper. As to the mercantile aspect of the case, it appeared the native merchants sent over indents calculated on a sterling value, so there was not much loss to the English manufacturer who was not a speculator. But it was to be observed that the native merchant took very good care before he fixed the amount in sterling of his indent, to provide for any possible loss which might accrue to him on the exchange. Now that could only mean taxing the people of India to some extent. The same difference between 2s. and 1s. 8d. had been lost, and of course it was lost owing to well known causes. Recently, certain continental nations which had been mono-metallic in the shape of having only silver, or bi-metallic, like France, having a silver and gold standard, became convinced by the reasoning of English economists that the best thing they could do would be to adopt the mono-metallic gold standard. At the end of the Franco-German war, when Germany found herself with rather more money than she usually had, she thought she would adopt a mono-metallic gold coinage; she demonetised a vast mass of the silver currency circulating amongst her people, and that conjointly with the increased output from the American mines, had the usual effect of over-production, and sent down the value of silver at one time even to 1s. 5d. The German Government then got alarmed, and put their silver on the market more gradually, so that it could be absorbed. The United States had tried the experiment of introducing silver into their currency, which had had the effect of absorbing a certain amount. It was a silver question, and in a world-wide sense, it was simply a question of supply and demand. If the world wanted so much silver, and about half as much again was produced as was required, the price must go down, whereas if the demand and supply were equal, it must remain at a fixed value. One word as to the duty of England with regard to bi-metallism. He thought the Bank of England, and the great economists of this country, were wise to adhere to the gold standard; in a mercantile community, it was very important in the making of contracts, that you should be able to refer them to a fixed standard, and gold practically was such a standard. If you attempted to fix the ratio between gold and silver, and made silver a legal tender, the result would be that contracts would be made payable in either gold or silver; if the market was flooded with silver, its value would go down, and everybody who had money to pay would want to pay in silver; and those who had to receive money would like to receive it in gold, and all sorts of confusion would arise. One thing, however, might, he thought, be done with advantage. Within the last few weeks, it had been seen that merchants, without any just reason, as far as their own trading was concerned, had had to pay a 6 per cent. bank rate. That was a serious thing to large mercantile houses, and still more serious for smaller traders, and was caused by the speculative break down in France, and the consequent abstraction of gold from this country. Now, if the Bank of England were to buy bar silver as one would buy any other merchandise, at the market price of the day, and the Government authorised it to issue notes against that silver, it would relieve pressure. The silver would not be coined and sent into the currency, but would be kept in the bullion department, and reckoned at its mercantile value. That might give ease to the money market, and would be a sort of bi-metallism, without the danger of a double standard.

Major SUART, R.E., said, as an old officer of the Bombay Mint, he fully concurred with everything in the paper with regard to India; but, with regard to any proposal to alter the legal basis of the currency of India, he could not conceive how it could be of any advantage, nor did he think it would be possible to effect it. The coinage of a gold currency for India, to be made concurrent with a silver currency, would require such a vast amount of gold that it would immediately disturb the relative values of gold and silver, and would be a most disastrous proceeding. To do this, it would be necessary to fix the ratio between gold and silver; but even the supporters of a bi-metallic currency had never been able to arrive at what that proportion should be, nor had they been able to say that it should be permanent, but suggested that there should be alterations occasionally. He could not conceive how the two standards were to be current simultaneously.

Mr. TRELAWNY SAUNDERS, entertaining very distinct ideas on this subject, thought it his duty to rise, although not entitled to do so as in any respect an authority. The depreciation of the rupee in the markets of England had been stated by the author of the paper, and was admitted to be a question of exchange; but it must be obvious that exchange was a matter entirely necessitated by trade between foreign nations, under different Govennments. The international arrangements which any Government might make in respect to its currency, and the value in any market, placed on the precious metals, did not at all influence other nations; therefore, any difference in the estimate of the value placed by different nations on their coinage and bullion must be a matter of regulation by the market according to the practice of exchange. In this case the rupee was not altered in value in India, and we had in London a coin practically identical with the rupee, namely, the florin, that had not altered in value. We had chosen, for the purposes of our currency, to make the florin a token, but we had it also in our power to make the rupee a token, and thus to make its value in London the same as it was in Calcutta, and why should not that be done? It was not so, simply because we had hitherto chosen to regulate the exchange with India as a country foreign to us; but India was part of the possessions of the Crown, and could be made subject to an Act of Parliament, and to the same or similar currency laws which operated in London. It was obvious to him, therefore, that the question of the difference in the value of the rupee was one at the mercy of the Legislature, and ought not to be subject, any more than the florin, to the variations in the value of silver bullion.

Mr. JAMES WOOD wished to make a remark on two points; one the statement in the paper with regard to sterling contracts, and the other referring to family remittances to England. In the first place he would point out what the nature of a sterling contract was, and to do that he must make a preliminary observation to show what was the remedy for breach of contract in England. If a man in England bought a house, and the contract was not fulfilled, he had two remedies. He might either have the house transferred to him by a compulsory process, putting the man in prison if he did not do it—this is called specific performance—or he might have a money payment for the loss he had sustained through non-performance of the contract, which was called the recovery of damages. If a man in England bought a bar of silver, and a seller refused to perform the contract, the only remedy in England was to be paid a certain weight in gold for the bar of silver. There was only one contract in England he would refer to, and that was on the Stock Exchange; if a man bought £5,000 of any stock, and the contract was not performed, his broker bought £5,000 of the same stock of somebody else and made the defaulter pay the difference. What was the remedy for a sterling contract in India? A man agreed to buy ten bales of cotton at 6d. a lb., say £150; the man failed to perform the contract, and the remedy the seller got was not £150 sovereigns, but a certain weight of silver, which the jury, at the time the case came on for trial, thought was the proper compensation for his loss. In all these cases, what the law aimed at, was presumably to put the person who suffered by the breach of contract in the same position he would have been put in if the contract had been carried out. The conclusion he wished to draw was this, and it certainly had something to do with bi-metalism, was it not worth considering whether you should not make a contract for payment in bullion, whether in India, England, or anywhere else, enforcible in a court of law, in the same way as you decreed specific performance in England? It required two persons to make a contract; you could not contract for payment in a certain metal unless the other person contracting agreed to it, but if you did agree to it, there ought to be some measure for enforcing the contract. Bi-metallism went on a different theory altogether. With regard to family remittances, there was a gentleman sitting near him who had had great experience in financial matters in Brazil, a country he had been in himself. Brazil has a paper currency, and he might say that the great difficulty now in Brazil hinged on this very question. The difficulty there was how to get immigrants, and the difficulty in India was how to find employment for coolies who went abroad. Few men would go to a foreign country unless in the expectation of returning home with increased wealth, and in the meanwhile sending remittances to their families. Now the very essence of sending or bringing home savings was to have something which, by mutual consent in the country you were sending the remittances to, or the country you were returning home to, would be of as much value as possible—in other words, one of two precious metals; and the point was that these contracts for payments in precious metals should be enforcible in the country where they were made.

Mr. BURJORJEE BROACHA remarked that Mr. Maclean said the depreciation of silver had given an impetus to the Indian foreign trade, and in that he was supported by Sir Richard Temple. Against two such authorities one was at a loss what to say, without resorting to figures, but that he would endeavour to do. In the five years, ending 1858-9, the average import and export of merchandise of India was 40 millions a year; in the five years ending 1868-9, it was 87 millions, an increase of 116 per cent. In the five years, ending 1878-9—the period of depreciation—the import and export trade, put together, was equal to 97 millions a year. Now in 1868-9, £1 sterling was worth 10 rupees, so that the 87 millions meant 87 millions sterling, whilst in the five years ending 1878-9, when the whole export and import of merchandise was 97 millions, a deduction of 12 per cent, or an exchange at 1s. 9d., had to be allowed for the depreciation of the rupee, so that in the last 10 years of the foreign trade, the seeming increase was no increase at all; while during the 10 years, from 1858-9 to 1868-9, it had increased 116 per cent. If India got 16 per cent. more for what she exported, she had to pay 16 per cent. more for what she imported; so that while the export and import trade balanced each other, the loss to the Government of India of three millions was a real loss. If India had to import more than she exported, what was she to make up her balance of trade in? If England imported more than she exported, she made up her balance in gold; but if India wanted to import more than she exported, she had an inexhaustible stock of silver, but this silver had no international exchange value. It was under the fostering care of the English Government that India had accumulated practically an inexhaustible treasure in silver, but it was a dead metal, and had no international exchange value.

Mr. E. WATHERSTON thought the members were under a great obligation to Mr. Maclean for his excellent paper; but like a great many other papers, the pith of the whole thing lay in the concluding paragraph, which referred to bi-metallism as the only thing which could extricate Europe from its difficulties. Another point which struck him was this; the idea of the writer seemed to be that it was an ill wind that blew nobody any good. There was decidedly an injury done to a large number of people by the extraordinary depreciation in the price of silver, but it was not altogether an unmixed evil. On the contrary, a great many people, and even the Indian nation itself, profited by it. He was not at all disposed to think that that was a wrong conclusion. No doubt, a great many people did gain by the depreciation of silver; but he was convinced of one thing, which had been proved to demonstration, that it would be a great gain to everyone, if there were a standard—even a double standard—of the currency, which would admit of Indians and Englishmen dealing together on a common standard of values. That remark applied to the whole world; if it were possible for the whole world to transact business on one common standard, there could be no doubt it would be a great advantage. But we ought to consider that we were living under one dynasty, that the Queen of England was Empress of India, and, therefore, he did not see why eventually the common sense of Englishmen might not arrive at the point when we could manage to deal with each other on a common standard. At the same time the difficulties in the way were very great, and he was not going to be Utopian, but he believed it was essential to the future well-being of both countries that we should conduct our mercantile organisations on a common basis. The price of silver had varied most remarkably for centuries. In the times of ancient Rome and Assyria, it was always in the proportion of 10 to 1; in the year 1600 it had come to about 10½ to 1; but in the year 1605 it was about 12 to 1. It was an undoubted fact that there was too much silver in the world. Now, was it a sensible proceeding on the part of the Government, when there was a large production of a certain commodity, which it certainly was in the interests of the whole world to consume, to tax that commodity and thereby reduce its consumption for manufacturing purposes? England had been foolish enough to demonetise silver in 1816, and also to tax silver in its consumption for manufacturing purposes, and his impression was that nothing could be more absurd.

Mr. WILLIAM BOTLY said, as the paper dealt with the question of bi-metallism particularly in its conclusion, it was very advisable that that part of the subject should be carefully considered, especially as there was a meeting convened at the Mansion-house, for the 8th of March, to consider the question. One gentleman had suggested that the Bank of England should store eight or ten millions sterling of silver and issue notes against it, but he remembered a proposition of that sort being made at the very time when the silver question was so much agitated, and it was then ridiculed, because it was said, supposing the Bank had done that, they must have sold the silver at some time, and the shareholders would have had no dividend at all. He did not see why an Act of Parliament should not make silver a legal tender up to £5.

The CHAIRMAN said the discussion had been of an extremely interesting character—nothing, in fact, from an economic point of view, could be more interesting than the problem Mr. Maclean had put before them. They had, in the case of India, an economical problem so unique and so complicated, that it might well occupy those interested either in abstract political economy, or in the important commercial affairs of the country. Here were two countries with different standards; the country which had a silver standard had to pay to the country which had a gold standard, and had to pay not in silver, but in gold; there came a sudden alteration in the value of silver, and, to add to the complications produced by all these facts, you had the silver, which had fallen enormously in its relations to gold all over the world, retaining and sustaining its value in India itself with regard to all Indian commodities. He did not believe so complicated a state of things had ever come under consideration, with adequate means of information, before. Mr. Maclean seemed to be of opinion that the fall in value of silver had not only stimulated, as it might have been expected to do, the export trade of India to England, but that it had likewise had a similar connection of cause and effect with the international trade. It was extremely difficult to believe, on economic principles, that that was the fact, and he should be disposed to think, himself, that those other causes to which Mr. Maclean had alluded, had had more effect in producing this result, namely, the great expansion of the railway system in India, combined with the great demand for wheat in this country, by excessive disastrous harvests. Whether he was right or wrong in that conjecture, nothing could be more certain than that the fall of silver could not be a permanent benefit, either to India, to England, or any other country in the world. If the process of depreciation had produced a good effect, that good effect must come to an end when silver had finally fallen to a stable value. Therefore, if the trade of India had been stimulated by the fall of silver, he was afraid they must consider that stimulation from some points of view artificial and temporary. However that might be, one thing was certain, whether India had gained or lost by the fall of silver, neither India nor England, nor any part of the world, could positively gain by an instability in the value of silver. It was for the interest of all that the standard of international exchange should be fixed and permanent. How that most desirable result was to be obtained was a question on which he would not then enter, and it seemed to him rather outside the limits of the discussion. Whether the plan Mr. Manuel had suggested, or the more thorough-going scheme of bi-metallism were the systems of the future, or whether we were to adhere to our present system, were amongst the pressing questions of the hour, but for that reason, if for no other, it would be most undesirable at that late hour to venture, either to continue the discussion, or to enter upon any new phase of it. He would, therefore, merely ask Mr. Maclean if he had any remarks to make upon the discussion which had taken place.

Mr. MACLEAN said he had very little to add, because the object of the paper was not to lay down a dogmatic rule, but to simply bring the actual state of India as clearly as possible before the meeting, to promote discussion, and to hear the different views entertained by different people on this subject. Mr. Broacha referred to what he conceived to be a falling off in the actual trade of India, but the figures which he had given in the paper showed an extraordinary increase of more than 50 per cent during the eight years ending in 1881.

Mr. BROACHA said that included bullion, whilst the former returns did not.

Mr. MACLEAN said that the value of the trade in 1873, taken at the exchange of that year, was much smaller than it would have been if the valuation had been taken in 1881, when the rate of exchange was much higher, so that the actual increase was greater than appeared in the returns, which showed that the trade of India had developed, and that the country was becoming exceedingly prosperous. He quite agreed that the real causes of the prosperity of India were, of course, not any particular accidental working of the machinery of currency, but must be sought far lower down; they were, undoubtedly, the prosperous harvests of the last few years, and the extraordinary development of trade caused by the construction of railways and other public works. But he believed that he had shown that the depreciation of silver had enabled the machinery by which these improvements were carried on to work much more smoothly and profitably than would otherwise have been the case. With regard to what Mr. Manuel had said, he would only remark that his proposition with regard to keeping so much silver in the vaults of the Bank of England, against notes to be issued, only showed to what straits the monometallists were reduced. Every one was beginning to see that it was necessary to use silver in one form or another. This gentleman proposed to keep a store of this metal—which was liable, as he said, to constant and violent fluctuations—in the vaults of the Bank of England as security against the issue of notes. But you might as well keep any other kind of merchandise in the vaults. If you proposed to use silver, you must give it a definite value in relation to gold, and then you would have something certain. That could be done if there were an international agreement with other nations; if all nations were agreed to have a fixed relative value between silver and gold, no nation could be left with a mass of the cheaper metal, whilst another would get the more valuable one, because the metals would have a certain fixed value to each other all over the world. There would be no dearer metal and no cheaper metal. The thing was to get an agreement amongst the nations of the world, and then yon would have a stability in exchange. He quite agreed with the Chairman, that any prosperity obtained by India from the fall in silver was artificial, and it would be better for her and all other nations that there should be a fixed standard between silver and gold to be agreed upon by all commercial countries. With regard to the taxation on silver, he thought it might very well be taken off.

The CHAIRMAN then proposed a vote of thanks to Mr. Maclean, which was carried unanimously.

TWELFTH ORDINARY MEETING.

Wednesday, February 22nd, 1882; Lord ALFRED S. CHURCHILL, Member of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Chandler, Josiah, 104, Newington-causeway, S.E.
Chandler, Samuel, 104, Newington-causeway, S.E.
Cottell, G. Lansdowne, 6, Tavistock-square, W.C.
Davies, Ferrand, 148, Gresham-street, E.C.
Duncan, James Morison, 24, St. James-villas, Addison-road, W., and 70, Queen-street, E.C.
Field, James John, North-lodge, New Barnet, Herts.
Forward, Henry, 3, Burr-street, E.
Hill, Arthur, Hayes-common, Kent.
Langdon, William Edward, Telegraph Department, Midland Railway, Derby.
Lorrain, J. G., 2, Victoria-mansions, Westminster, S.W.
McMillan, Walter George, F.C.S., 104, Jermyn-street, S.W.
Reynolds, Lieut. John H., Guards' Club, S.W.
Ullyett, Arnold Henry, Lyell-house, Folkestone.
Wood, Charles George. 4, Talbot-place, Blackheath, S.E.

The following Candidates were balloted for and duly elected Members of the Society:—

Campbell, Colonel Walter M. T., R.E., 99, Eaton-place, S.W.
Graham, C. Colborne, F.C.S., 29, Wilberforce-street, Hull.
Johnstone, William, Chemical Laboratory and Assay Office, Athenæum-chambers, King's Lynn.
Kennett, Richard, 8, Maddox-street, Regent-st., W.
Kinch, Prof. Edward, Royal Agricultural College, Cirencester.
Pointer, Harry, 11, Bloomsbury-place, Brighton.
Thomas, Evan William, 32, Bow-street, W.C.

The paper read was—

THE PRODUCTION AND USE OF GAS FOR THE PURPOSES OF HEATING AND MOTIVE POWER.

By J. EMERSON DOWSON.

All here this evening are accustomed to the use of coal gas for lighting purposes, and by many it is looked upon as almost a necessity. It is, in fact, hard to realise that so extensive a use of it has been developed during little more than half a century. Fifty years ago, nearly all towns were lighted, or said to be lighted, with miserable oil lamps, and now the capital publicly invested in works for the supply of gas in the United Kingdom amounts to something like 45 millions; and, for London alone, it is over 13 millions sterling.

The manufacture of lighting gas, on so large a scale, has naturally led to the improvement and cheapening of its production; and this, again, has led to its more extended use for lighting, and to its adoption to a certain extent for heating and motive power. This more general use has led us to become familiar with the advantages of gas as a fuel; but we have also learnt the unpleasant fact that its use for such a purpose is generally attended with much more expense than when coal or coke fires are used. We now know that gas-engines are theoretically more efficient than hot-air or steam-engines, and we know that they cannot burst like steam-boilers; but their general adoption is greatly impeded by the high price of the fuel they require.

Ordinary coal gas is also admirably adapted for cooking and innumerable heating purposes, but in the hands of careless persons (and they out-number the careful ones) it is certainly not economical, compared with coal or coke. Supposing, however, that gas were at such a price that it could be extensively used for fuel, its consumption would be enormous, and as it would greatly reduce the quantity of raw coal used in open grates, the smoke nuisance from which we suffer so seriously in large towns, would, without doubt, be sensibly abated. We see, therefore, that much may be gained by our having suitable gas at low cost for heating and motive power, but we have not yet determined how this is to be accomplished. It is, however, a question bearing directly on our health and comfort, and on fuel economy; and as such, it is one of national importance, and therefore deserving of our best attention.

What we really have to do is to consider separately the question of gas for lighting, and of gas for heating; and until this is done, and until we appreciate the principles involved in each case, I fear we shall not arrive at sound and practical conclusions. First, therefore, it will be well for us to remember that, after all, our so-called lighting gas has a very small per-centage of illuminating constituents. Rich Manchester gas has only about 6½ per cent., and ordinary London gas so little as 4 per cent. Roughly speaking, average London gas consists of hydrogen, 52 per cent.; marsh gas, 35 per cent.; carbonic oxide, 8 to 9 per cent.; and olefiant gas, 4 per cent., so that in every 100 cubic feet we have about 96 cubic feet of non-luminous heat-giving gases, and only 4 cubic feet of luminous gas. The addition, however, of this small proportion of illuminants adds very greatly to the trouble and cost of preparing the gas, and although this addition is essential for lighting, it is not in the least necessary or desirable for heating purposes.

In the phenomena attending the combustion of lighting gas, the non-luminous heating gases serve to raise the temperature of the carbon particles to a white heat, and it is the incandescent carbon which produces the lighting effect. It is, therefore, consistent with the teaching of science, that there should be a large preponderance of heat-giving gas present with the lighting gas, although we have certainly not obtained the best possible proportions in our London gas. We have now to consider what occurs when we use lighting gas for heating purposes, and we shall see that other conditions then obtain. As a matter of fact, when such gas is used as a heating agent, the first thing we almost invariably do is to destroy its luminosity, by the Bunsen, or other atmospheric burners, or blow-pipes, used. Here I have a jet of ordinary lighting gas, and if I wish to heat a vessel with it, I cannot let the gas touch the vessel without a deposition of soot, owing to its cooling effect on the flame, and this involves a loss of heat, the soiling of the vessel, and a waste of gas. If I place the gas jet so far under the vessel that the tip of the flame is not in contact with it, I lose much heat, radiated from the sides of the flame, and in cases where a concentrated heat is required, there would also be difficulty in burning the needful quantity of gas. To meet these difficulties, we use a burner, or a blow-pipe, which causes a certain quantity of air to mix with the gas before it is ignited, But as you see, the immediate effect of this is to destroy the luminosity of the flame, for the carbon is brought into such close proximity to the oxygen of the air, and their chemical combustion takes place so rapidly, that apparently there is no intermediate stage of incandescence.

It is true that olefiant gas has a high calorific power, but it is less than that of hydrogen or marsh gas, and it can be well replaced by either of the latter, where heat only is required. We see, therefore, that the presence of the costly illuminating constituents in ordinary coal gas is not only unnecessary for heating purposes, but adds considerably to the difficulty of using it. It then naturally occurs to one to ask, are we right in adhering to the ordinary method of producing gas when required for heating purposes, and cannot other suitable gas be obtained at less cost than ordinary lighting gas? It is my belief that both these questions can be answered in the affirmative, and I will give you my reasons.

In the first place, it has long been established, and is well known, that highly heating non-luminous gases can be produced by decomposing steam in the presence of incandescent carbon, and it only remains to prove that the process can be carried out in a simple way at a moderate cost. Dr. Siemens was the first to prove to the world on a practical scale, in conection with regenerative furnaces, the great economical and other advantages of using cheap gaseous fuel. This is now matter of history, and his system, or some close imitation of it, has been adopted in all manufacturing countries. In the Siemens gas producer, air only, or air mixed with a small quantity of steam, passes through a mass of red-hot fuel, and gas so made, answers extremely well when used in large quantities, and when highly heated in the regenerative chambers of a furnace. It however contains 60 to 70 per cent. of nitrogen, and this large proportion of incombustible gas renders it unsuitable for use in small quantities, as for instance, in ordinary gas burners, or in gas-engines, &c. Many other systems have been tried, but it would serve no useful purpose here to describe all that has been done in this direction. Suffice it to say, that the early attempts chiefly consisted of passing steam through iron retorts, charged with carbonaceous fuel, rendered incandescent by external fires. The steam was decomposed, and some of the oxygen combined with the carbon of the fuel, but some of the oxygen also combined with the iron of the retorts, and the process was necessarily abandoned. Messrs. Kirkham introduced the method of decomposing steam by passing it through a column of fuel previously rendered incandescent by an air blast. In this way external fires were dispensed with, and as the retorts could then be lined with refractory material, their oxidation was prevented, and the working cost was considerably reduced. Air was first forced into the generator, until the temperature of the fuel was very high. The air inlet was then closed, and steam was let in. The latter was at first readily decomposed, but at the expense of much heat withdrawn from the fuel; and soon it was necessary to turn off the steam and again introduce the air blast. To make up for the want of continuousness in the process, two generators were worked alternately, and this, and the constant variation in the temperature of the fire, caused serious fluctuations in the quality of the gas.

Many modifications of Messrs. Kirkham's apparatus have since been introduced, but nearly all depend on the intermittent passing of air and steam through the fire. We have already seen that Dr. Siemens has, in some cases, adopted the plan of passing a mixture of steam and air through a fire, and although his gas is weak, it has the advantage of being continuously produced, and of being uniform in quality. In 1875, Mr. J. Kidd patented an apparatus, by which he made somewhat similar gas, and a paper on it was read before this Society, in April, 1878. The chief novelty in this apparatus was the placing of a coil round the sides of the gas generator, so that water introduced into the coil might be converted into steam by the heat of the generator fire, the steam thus produced being afterwards passed through the fire, and there decomposed. This answered well when the fire was carefully attended to, but if it was neglected for a short time, wet steam and water passed from the coil, and the apparatus soon became unmanageable. Careful experiments with this gas showed that its calorific power was only 20 per cent. that of ordinary London gas, while the temperature of combustion was also much less than that of the latter.

With your permission, I will now describe briefly the apparatus of which there is a model before you. This model is half the actual size of a generator which produces 1,000 cubic feet an hour. In this system I have imitated Dr. Siemens and Mr. Kidd, in passing a mixture of steam and air through a fire, but I have adopted special means for producing and superheating the steam, and for maintaining all the conditions of working constant and simple, and by so doing, I have sensibly improved the quality of the gas produced. A full-size vertical section of the whole apparatus is shown on the diagram, and from this it will be seen that the steam-producer and super-heater consists of a long length of tubing bent in such a way as to bring nearly the whole of it over some gas flames underneath. Water, at a pressure of 20 to 25 lbs. per square inch from a town supply, from an overhead cistern, or from a pump with accumulator, is passed into the coil, and there converted into super-heated steam. When the cock regulating the inlet of water has been adjusted, and when the gas has been lighted under the coil, the conditions as to temperature and pressure are constant, and this part of the process needs no further attention. The gas required for heating the coil is drawn from the gas-holder, but on the first occasion of starting the apparatus, or whenever there is no gas in the holder, a fire is lighted on a grate under the coil. The retort, or generator, has an iron casing, to make it gas-tight, and this is lined with ganister, as in a foundry cupola, to prevent loss of heat and oxidation of the metal. The fire rests on a grate, and under the latter is a closed chamber, into which a jet of the super-heated steam plays, acting as an injector, and carrying with it, by induction, a continuous current of air. The pressure of the steam forces the mixture of steam and air upwards, through the fire, so that a high temperature of the fuel is maintained, while a continuous current of steam is simultaneously decomposed. In this way the working of the generator is very regular, and the gas is produced rapidly, and without fluctuations in quality. The well-known reactions occur: the steam is decomposed, and the oxygen from the steam and air combines with the carbon of the fuel to form carbonic acid, which is reduced to the monoxide on ascending the fuel column. Approximately the composition of this gas by volume, is hydrogen 20 per cent., carbonic oxide 30 per cent., carbonic acid 3 per cent., and nitrogen 47 per cent.

Where uniformity of pressure is required, as for engines, burners, &c., or where storage is needed, the gas is passed into a holder. This somewhat retards the production, but the injector causes gas to be made so rapidly that a holder is easily filled when weighted to give a pressure of 1″ to 2″ of water, and at this pressure a generator can pass gas continuously into the holder, while at the same time it is being drawn off for consumption. For boiler and furnace work, the gas can be used direct from the generator, and in such cases, where there is no gas-holder, I do not use the super-heater above described, but I produce the steam in the gas generator itself. Instead of solid bars for the grate, I use hollow ones, and these I connect together in such a way that the water or steam passes through each bar successively. The heating of these bars is not liable to fluctuations, because the heat to which they are exposed is but slightly affected by any variation in the fuel column above them.

The nature of the fuel required depends on the purpose for which the gas is used. If for heating boilers, furnaces, &c., coke or any kind of coal may be uesd; but for gas-engines, or any application of the gas requiring great cleanliness and freedom from sulphur and ammonia, it is best to use anthracite, as this does not yield condensable vapours, and is very free from impurities. Gas made by this process, and with anthracite coal, has no tar and no ammonia, and the small per-centage of carbonic acid present, does not sensibly affect the heating power. A further advantage is, that it cannot burn with a smoky flame, and this is of importance for the cylinder and valves of an engine, and renders it much more easy to apply it to cooking and other stoves than when lighting gas is used. At present, all gas stoves are but compromises, for some of the difficulties attending the use of ordinary lighting gas for cooking and heating purposes are so great, that the makers have failed to overcome them. With a gas, however, which requires little air for its combustion, and which cannot give off smoke or cause a soot deposit, these difficulties nearly all disappear.

About seven pints of water and 12 lbs. anthracite produce 1,000 cubic feet of my gas, but $\frac{1}{10}$th, $\frac{1}{12}$th, and $\frac{1}{15}$th of the gas so made is required to produce and superheat the steam in the A, B, and C sizes respectively of the apparatus used. We have, therefore, an effective production of 900 to about 930 cubic feet, or a mean of, say 915 cubic feet per 12 lbs. of anthracite, allowing 8 to 10 per cent. for impurities and waste. A ton of anthracite produces therefore 170,740 cubic feet, of which about half are combustible.

The cost of manufacture depends to a certain extent on the scale of working, and the figures I am about to give you are unfavourable to myself, because they do not represent working on a large scale, when the expenses would be spread over a large production. No skilled labour is necessary, and in practice, where a single generator is required, it is usual to employ a man who has other work to attend to near the generator, and to pay him a small addition to his ordinary wages. A reliable statement of the actual cost of producing the gas in single generators of the three sizes in use, is given in the following Tables, 1, 2, and 3.

TABLE 1.

Generator A size (producing 1,000 *cubic feet per hour).*

	s.	d.
Anthracite = 12 lbs. × 9 working hours = 108 lbs.—or, say 1 cwt. at 15s. a ton ...	0	9
Allowance for wages of attendant	1	0
Repairs and depreciation of generator, gasholder, &c., 5 per cent. on £125 = per working day	0	5
Interest on capital outlay ,, ,, ,,	0	5
Total....	2	7

	Cubic Feet.
Gas produced	9,000
Less gas used for generating and superheating steam	1,000
Total effective gas for 2s. 7d.	8,000

Net cost, say 4d. per 1,000 *cubic feet.*

TABLE 2.

Generator B size (producing 1,500 *cubic feet per hour).*

	s.	d.
Anthracite = 18 lbs. × 9 working hours = 162 lbs.—or, say 1½ cwt. at 15s. a ton..	1	1½
Allowance for wages of attendant..........	1	0
Repairs and depreciation of generator, gasholder, &c., 5 per cent. on £140 = per working day	0	5½
Interest on capital outlay ,, ,, ,,	0	5½
Total....	3	0½

	Cubic Feet.
Gas produced	13,500
Less gas used for generating and superheating steam	1,200
Total effective gas for 3s. 0½d.	12,300

Net cost, say 3d. per 1,000 *cubic feet.*

TABLE 3.

Generator C size (producing 2,500 *cubic feet per hour.)*

	s.	d.
Anthracite = 30 lbs. × 9 working hours = 270 lb. at 15s. a ton	1	9½
Allowance for wages of attendant	1	6
Repairs and depreciation of generator, gasholder, &c., 5 per cent. on £160 = per working day	0	6½
Interest on capital outlay ,, ,, ,,	0	6½
Total....	4	4½

	Cubic Feet.
Gas produced	22,500
Less gas nsed for generating and superheating steam	1,500
Total effective gas for 4s. 4½d.	21,000

Net cost, say 2½d. per 1,000 *cubic feet.*

From these Tables it will be seen that, allowing 1s. to 1s. 6d. a day for the proportion of the attendant's time required for feeding the generator, the total cost of production (including depreciation, and interest on capital outlay) is 4d., 3d., and 2½d., for the A, B and C sizes respectively, or a mean of about 3d. per 1,000 cubic feet.

The calculated calorific intensity or the pyrometric effect of London gas, of the composition before stated, is 2554° C. (4629° F.), and of my gas 2268° C. (4114° F.) The calculated calorific power of 100 litres of the London gas, or the number of grammes of water which they can raise one degree Centigrade, is 559,038, and of 100 litres of my gas 155,836 grammes. From these figures you will see that 3·5 volumes of my gas are required to give the same calorific power as one volume of the London gas, and that therefore we must multiply the cost given in tables 1, 2, 3, by 3·5, to give that of the equivalent of 1,000 cubic feet of the coal gas. Another practical consideration is that coal gas requires 224 to 250 lbs. of coal per 1,000 cubic feet of gas, but my gas requires only 12 lbs. per 1,000 cubic feet; and multiplying this by 3·5, to give the equivalent of 1,000 cubic feet of coal gas, we have 42 lbs. instead of 224 to 250 lbs. This is only 16·5 to 18 per cent. of the weight of the coal required for coal gas; and in reference to the cost of transport, this will effect an appreciable saving in many outlying districts.

Although my apparatus is not very large, I cannot, of course, work it in this hall; but I have here a bag of my gas, and I will show you some of it burning. This is an ordinary Bunsen lamp, and before opening the air inlets, I would ask you to notice that when a piece of porcelain or bright metal is held over or in the flame, no soiling or deposition of soot takes place. I will now open the air inlets, and you will see that I can readily heat a piece of platinum, and that notwithstanding the presence of so much nitrogen in the gas, there is very considerable heat energy developed; in fact, the effect produced is very similar to that obtained with coal gas. This can be explained by the fact that one volume of ordinary London gas requires, theoretically, 5·24 volumes of air for its combustion, and yields 61·3 volumes of combustion products, at the temperature of ignition, whereas one volume of my gas requires 1·2 volumes of air, and yields, at the temperature of ignition, 18·1 volumes of combustion products. If we then multiply the 18·1 by 3·5, we have a total of 63·3, compared with 61·3, as the volumes in each case, over which the heat of combustion is distributed. I have not gas enough here to make the experiment, but I may mention that I have fused ½ lb. of cast-iron in an ordinary Fletcher furnace of small size.

One of the most convincing proofs, however, that this gas has considerable heat energy, as well as uniformity of quality, is the fact that it can be used satisfactorily for driving gas-engines. This is no mere opinion of mine, but a fact established by several careful trials made during the past two years, with some of the well-known "Otto" engines. At the Smoke Abatement Exhibition, recently held at South Kensington, my gas has been in daily use for about three months, to drive an "Otto" engine, working a Siemens dynamo-machine, and some Swan electric lights; and the fact that these lights have been uniformly steady is, I think, a good practical proof that the gas is suitable for engine purposes, and that the quality is constant. I may also mention that the English makers of these engines, Messrs. Crossley Bros., Limited, are so satisfied with the suitability and economy of this gas for their engines, that they are now laying down plant to work an aggregate of 200 h.p. with it.

The comparative explosive force of the two gases is as 3·4 to 1, *i.e.*, coal gas has 3·4 times more energy than the Dowson gas. But because the combustion of the carbonic oxide proceeds more slowly than that of the carburetted hydrogen gases, and because the diluents present in the cylinder affect the weaker gas more than the coal gas, in practice with an "Otto" engine, 5 volumes of the Dowson gas are used for one volume of coal gas. Allowing for this, the results of working some 3½ (nominal) h.p. engines have shown that about 110 cubic feet of the Dowson gas are required per indicated h.p. per hour, the indicator diagrams nearly resembling those obtained with coal gas. We have seen that 12 lbs. of anthracite produce 1,000 cubic feet of my gas, and that for the A size apparatus, 100 cubic feet per hour are required to produce and superheat the steam used in the generator, so that with this size we have an effective production of 900 cubic feet from 12 lbs. of coal. From this, we see that the above trials, with quite a small engine, have proved that one h.p. indicated per hour is obtained with a consumption of gas derived from 1·46 lbs. of coal, after allowing for impurities and waste of the latter. The "Otto" engines of larger power consume less gas per h.p. than the small ones, and it is not unreasonable to suppose that the result of working the large engines now being prepared for my gas, will be a fuel consumption of very little over 1 lb per indicated h.p. per hour.

The economical results are important, as you will see by referring to the following Tables, 4 & 5.

TABLE 4.

Working cost of steam-engine indicating 35 horse power, for 2,500 hours (50 weeks of 50 hours each.)

	£	s.	d.
Coal = 35 h.p. × 4 lbs. × 2,500 = 156·2 tons at 15s.	117	3	0
Water at 2 gals. per indicated h.p. per hour = 175,000 gals. at 9d. per 1,000	6	11	3
Oil and waste at 5s. a week × 50	12	10	0
Wages of fireman at 21s. a week × 50	52	10	0
Repairs and depreciation, 15 per cent. on £380, price of engine and boiler fixed	57	0	0
Interest, 5 per cent. on £380	19	0	0
	£264	14	3

$\frac{\text{£264 14s. 3d.}}{\text{35 h.p.}}$ = £7 11s. 3d. per indicated h.p. per annum.

TABLE 5.

Working cost of "Otto" engine, with Dowson gas, indicating 35 h.p. for 2,500 hours (50 weeks of 50 hours each).

	£	s.	d.
Dowson gas required = 18 cubic feet × 5 = 90 cubic feet per indicated h.p. per hour ∴ total required = 35 h.p. × 90 × 2,500 = 7,875,000 cubic feet, and anthracite required for 7,875,000 cubic feet + allowance of 375,000 cubic feet for superheated steam = 8,250 × 12 lbs. = 44·2 tons at 15s.	33	3	0
Water for making gas, say 8,000 gals., at 9d. per 1,000	0	6	0
Water for cooling engine	0	10	0
Oil and waste at 5s. a week × 50	12	10	0
Wages of attendant to feed generator, at 10s. 6d. a week × 50	26	5	0
Repairs and depreciation, 10 per cent. on £390 and £170, prices of engine and gas apparatus fixed	56	0	0
Interest, 5 per cent., on £560	28	0	0
	£156	14	0

$\frac{\text{£156 14s. 0d.}}{\text{35 h.p.}}$ = £4 9s. 6d. per indicated h.p. per annum.

In Table 4 I have given in detail the yearly cost of working a steam-engine indicating 35 h.p., and consuming 4 lbs. coal per indicated h.p. per hour, the number of working hours being 50 weeks of 50 hours each. In Table 5, I have given the yearly cost of working an Otto engine with my gas, during the same time, and indicating the same power. This mode of comparison is, to a certain extent, unfavourable to the gas-engine; for, in practice, an engine has seldom the same load all day and every day, and, with this class of engine, the governor admits only the quantity of gas required for the actual power to be developed. The gas is in fact bottled up, so to speak, in the holder, and is admitted into the cylinder in the precise quantities required. With steam, however, the boiler fires cannot be regulated to suit exactly the varying power required. In practice, the average power may be taken as about one-third to one-half less than the maximum; but, without allowing for this in any way, and supposing that each engine is working up to a uniform power all the year, we find that the steam-engine costs £264 14s. 3d., or £7 11s. 3d. per indicated h.p. per annum, and the gas-engine, £156 14s., or £4 9s. 6d. per indicated h.p. per annum. This is an economy of over 40 per cent. in favour of the gas-engine, when worked with my gas. Moreover, the saving in weight of coal in favour of the latter, compared with the steam-engine is, as 44 to 156 tons = nearly 72 per cent.

I have shown you that this gas can be made very rapidly, and at very low cost, even when produced on a small scale. I have also shown you that it has a considerable heat energy, and that it cannot cause a soot deposit; and I have given you reliable data obtained with actual trials on gas-engines. In fact, I have shown you its superiority and great economy, compared with coal gas, for all purposes of heating and motive power, and I think you will, therefore, agree with me, that for factories, large houses, and public institutions, it has many and great advantages.

For the supply of large towns many other considerations obtain, and there is no immediate probability of great changes being made by the companies who have the legalised monopoly of the pipe-laying, and whose prosperous condition is against the making of radical changes. I think, however, it may interest you to have a few particulars relating to coal-gas manufacture, so that you may better appreciate the general bearings of the case. In the first place, I would refer you to Tables 6 and 7, which show the total cost of making and distributing gas for the four metropolitan and thirteen suburban gas companies.

TABLE 6.

Statistics of Four Metropolitan Gas Companies for 1880.

	s.
Selling price for 16-candle-power gas, per 1,000 cubic feet	3·39
Total gas sold in year—about 18,091¼ million cubic feet.	

Gas sold per ton of coal carbonised—9,529 cubic feet.

Coke made per ton of coal carbonised—44 bushels.

Coke used for fuel—26 per cent. of make,

Per 1,000 cubic feet sold.

	d.	d.
Cost of coals		18·43
Less residuals—Coke and breeze	5·58	
Tar and products	3·59	
Ammonia and products	2·86	12·03
Net cost of coals		6·40
Manufacturing charges:—		
Purifying	·91	
Salaries	·41	
Wages (carbonising)	3·58	
Wear and tear	4·93	9·83
Working expenses:—		
Distribution	2·20	
Rent and taxes	1·38	
Management	1·30	
Law charges	·11	
Bad debts	·26	
Public officers, &c.	·05	
Depreciation of works on leasehold	·02	
Other charges	·25	5·57
Total net cost		21·80

Names of Companies.—Commercial, Gas Light and Coke, London, and South Metropolitan.

TABLE 7.

Statistics of 13 *Suburban Gas Companies for* 1880.

Selling price for 14-candle-power gas per 1,000 cubic feet ... s. 4·2

Total gas sold—about 2,310 million cubic feet.

Gas sold per ton of coal carbonised—9,428 cubic feet.

Coke made per ton of coal carbonised—46 bushels.

Coke used for fuel—28 per cent. of make.

Per 1,000 cubic feet sold.

	d.	d.
Cost of Coals		21·19
Less residuals:—Coke and breeze	6·97	
Tar and products	2·30	
Ammonia and products	2·07	11·34
Net cost of coals		9·85
Manufacturing charges:—		
Purifying	·96	
Salaries	·65	
Wages (carbonising)	4·30	
Wear and tear	5·43	11·34
Working expenses:—		
Distribution	1·80	
Rent and Taxes	1·91	
Management	3·21	
Law charges	·03	
Bad debts	·24	
Depreciation of works on leasehold	·21	
Other charges	·04	7·44
Total net cost		28·63

Names of Companies:—Barnet, Brentford, Bromley, Colney Hatch, Croydon, Crystal Palace, Lea Bridge, Mitcham, Richmond, Tottenham, Wandsworth, West Ham, and Woolwich.

These Tables are based on Mr. Field's well-known and carefully-compiled analyses of the metropolitan and suburban gas companies' accounts, and I have taken the last year for which these analyses have been published. I have purposely kept the four metropolitan companies separate, because they represent undertakings so huge that certain items of working cost are lower than where the manufacture is on a more moderate scale.

Taking Table 7, which gives the average of thirteen companies, we find that the total net cost of 1,000 cubic feet of 14-candle-power gas sold was over 2s. 4½d., after allowing for the sale of residuals, and without including anything for dividends or interest on the capital outlay. We may then ask—"What probability is there of this cost being reduced by further improvements in the present system of gas-making?"

I think we may assume that the items given under "working expenses" are not susceptible of much change, and we may as well confine our attention to the other headings. In the weight of coals, and in the wages for carbonising, it is probable that some saving will be effected when cheap generator gas is used for heating the retorts, instead of the present coke fires. It is also possible that the prices realised for about half of the residuals, *i.e.*, for the tar and ammonia, may increase as new discoveries are made affecting their chemical treatment. But after fully allowing for these, we are then forced to the conclusion that, except in localities specially favoured, there is no probability of large reductions being made in the present cost. We have, however, seen that there is a growing need for much cheaper gas for heating and motive power, and my own belief is that this need will not be satisfied until we have an abundant supply of gas for such purposes at 1s. per 1,000 cubic feet. To obtain this, however, I also think that the present system of gas-making will have to be departed from.

At the meeting of the British Association of Gas Managers, held at Birmingham, in June, 1881, Dr. Siemens gave some interesting particulars of the varying candle-power of the gas produced in ordinary retorts, at different stages of the process of distillation. He showed that, during the first and last stages, the gas given off was of inferior lighting power; and that, for about two-thirds of the whole period of distillation, between the first and last stages, the gas given off was of superior lighting power. From this, he argued, that the richer gas should be drawn off separately, and sold as lighting gas, and that the gas made during the first and last periods should be distributed and sold separately for heating purposes. It is with some diffidence that I venture to offer an opinion against so high an authority on these subjects; but I think it right to say that I see an insuperable practical difficulty in carrying out this suggestion. Such a system would depend on the consumption of the heating and lighting gases respectively following exactly the proportions in which each is produced, and how to effect this without serious trouble and complication in the storage and distribution, I fail to see. It was also urged in the discussion which followed, at the above meeting, that the companies would certainly sustain a loss if they continued to manufacture by their present method, and were to sell only two-thirds of their production as lighting gas, and one-third, at a much cheaper rate, as heating gas. Surely it would be simpler and better to make separately, and in distinct apparatus, rich gas for lighting, and the cheapest possible gas, with coke and decomposed steam, for heating and motive power. The production of each kind of gas could then be easily regulated to suit the consumption.

It has further been suggested that when gas is made solely for heating purposes, it need not be purified at all, or very slightly; but I beg to protest strongly against the adoption of such a suggestion. Tables 6 and 7 show us that the cost of purifying gas for lighting is about one penny per 1,000 cubic feet sold, and such a small saving would never compensate for the loss due to the corrosion of metals and the injury to health which would inevitably follow the liberation of sulphur and ammonia compounds.

That gas for motive power will play a most important part in the future is, I think, beyond doubt; and in confirmation of the views I have expressed on this subject, I would remind you of two important statements which have recently received much public notice. In the first place, so high an authority as the Chairman of Council of this Society has told us in his inaugural address that "the average steam-engines in use throughout the United Kingdom certainly do not give one twenty-fifth of the energy which may be taken as residing in the fuel they consume." He also referred to the excellent work done by gas-engines, and remarked: "There are many temptations to the use of a good gas-engine. There is no fear of the boiler blowing up, no fear of its being injured for lack of water, no stoking is needed, hardly any attention is necessary; and having regard to the great requirement for electrical illumination in clubs, theatres, and even in private houses, there appears to be a very large future for this kind of motor." Then Professor Ayrton has recently shown* that the internally fired gas-engine has a much higher theoretical efficiency than a steam or hot-air-engine. He has, however, pointed out that a gas-engine, burning illuminating gas, is in the same position as was, a few years ago, an electro motor for which, until quite recently, zinc was the fuel burnt for producing the electricity. In his remarks he said: "If it be possible to manufacture a cheap heat-giving gas, small gas-engines driven with such gas, will not only surpass, in economy, steam-engines of the same size, but will produce energy at a cheaper rate per horse power than the largest steam-engines ever made."

It may be that the demand already existing for heating-gas is not sufficient to warrant the gas companies in putting down separate mains, but I feel sure that the question is one of growing interest, and that gaseous fuel will, sooner or later, be one of the important factors in our industrial and domestic arrangements. The apparatus I have described to you this evening is already being used for several manufacturing and other purposes, and for motive power; and it remains to be seen how far the companies who supply gas to towns may find it to their advantage to adopt a modification of the process.

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* "On the Economical Use of Gas-engines for the Production of Electricity," by Professor W. E. Ayrton, F.R.S. F. & N. Spon, Charing-cross.

DISCUSSION.

The CHAIRMAN having invited discussion,

Mr. COLES said he could personally endorse what had been said by Mr. Dowson as to the efficiency of the gas that was produced at the Smoke Abatement Exhibition. It was there used in an "Otto" gas-engine, for driving a Siemens dynamo-machine, and lighting some Swan lamps; also for cooking purposes, in one of Billings' stoves, in Dr. Adams' heating stove, and for laundry-irons; and on account of its cleanliness, it seemed to answer very well for the latter purpose, as well as for the others. During the time the apparatus was at South Kensington, it worked without any accident or difficulty, and altogether, the results were very sasisfactory to the Committee. The precise results of the trials the Committee had been carrying on, he was not in a position to state at the moment, but they would be published in due course. Beyond that, he would say that he had seen the apparatus at work in Paris, where it gave general satisfaction. These facts seemed sufficient to indicate that the gas could be practically manufactured and applied.

Sir E. INGLEFIELD, F.R.S., asked if a burner could be attached to the pipe so as to show the difference of illuminating power between this and ordinary gas.

Mr. DOWSON said this was practically a non-luminous gas. If an ordinary Argand burner were used, it would have no illuminating power. If it were used for lighting purposes, it had to be enriched with some other material.

Sir E. INGLEFIELD also asked if any attempt had been made to utilise it for boiler purposes, and if it could be used for driving engines on board ship.

Mr. QUINLAN asked if there were anything objectionable in the manufacture. Very often leases contained a clause that no objectionable manufacture should be carried on, and it would be desirable to know whether there was any unpleasant smell connected with it.

Mr. LIGGINS said he had taken some interest in this process during the last three months. He had watched its operation very carefully at the Smoke Abatement Exhibition, and it appeared to him to be a valuable gas for heating purposes. But he was reminded by it of a very tempting apple at the top of a high tree, quite out of reach, for it seemed to him it would be almost impossible to get this gas where it was required. Take the residences in South Kensington; how could they set up an apparatus for heating, cooking, and driving a small engine for electric lighting? He did not think the landlords would permit it, and probably one's neighbours would not sanction it for fear of explosions. He believed this was not so explosive as ordinary gas, but still there would be an objection to its general introduction. He for one, as an old vestryman of Kensington, should rather dread an application being made for permission to rip up all the streets and to lay down an independent set of pipes, though no doubt the gas would be of great use if it could be easily procured. He attached great importance to the introduction of such a gas for heating and cooking purposes, as it would to a great extent abolish the smoke nuisance, which was, at present, so oppressive.

Mr. MAXWELL LYTE asked what method was proposed to be employed for rendering the presence of this gas noticeable in a building. It certainly appeared to be less explosive than ordinary gas, but still it was explosive, and if it could be given off in the interior of a building, unperceived by its smell, it would be a dangerous thing to introduce into London houses. They knew that rats sometimes gnawed through pipes conveying gas, and thus produced leakages, which occasionally caused serious accidents. Settlements of masonry, and other accidents, also produced the like effects, and therefore it was important to know if Mr. Dowson had introduced any method of giving some odour to this gas, by which its presence might be detected.

Mr. EASTICK said he presumed Mr. Lyte's objection applied to the presence in the Dowson gas of carbonic monoxide in a much greater proportion than in ordinary illuminating gas.

The CHAIRMAN said they were all much indebted to Mr. Dowson for his interesting paper, in which he had described a new method of making gas, calculated to be of great service. He (the Chairman) had watched this process for some years, and always thought that it would be found most useful. A friend of his had his house fitted with the gas, and not only used it for heating purposes in the kitchen, but carburetted it, and used it for lighting purposes. The great feature about it was its cheapness as compared with coal gas, for the purposes for which it was intended, namely, for heating, and for use in gas-engines. They had seen its heating power, when a current of air was passed into it; and he had no doubt that if it were employed in the Siemens furnace, considerable results might be obtained. With regard to its use as an explosive in gas-engines, the fact that Messrs. Crossley were now erecting machinery for the purpose of supplying an engine of 30 or 40-horse power with this gas, was a conclusive proof that practical men were sufficiently satisfied with it to make further experiments. Mr. Dowson calculated that with an engine of that sort it would take about one pound of coal per indicated horse-power, which was a considerable reduction from what they had been accustomed to in small engines, and if he succeeded so far, he would have accomplished a great economy. Mr. Liggins appeared to be doubtful about the advisability of introducing it in small houses in Kensington, and he did not suppose it would be much introduced there; it would be more in situations where there was space for the erection of the apparatus. But these seemed minor objections, which would, no doubt, disappear as time went on, and the invention became more developed. He concluded by proposing a hearty vote of thanks to Mr. Dowson, which was carried unanimously.

Mr. Dowson, in reply, said with regard to the question whether this gas could be advantageously applied to the heating of boilers for vessels, he might say that he had used it to a certain extent for boiler work, but not on a very large scale, and he hesitated to say off-hand that it would be suitable for the ordinary setting of boilers, because they had generally large flues, which would lead to a great deal of waste, after having gone to the expense of converting the fuel into gas. But by making proper arrangements for the burning of the gas advantageously, he believed there was a chance for it in this direction. As to the question whether there was anything objectionable in the manufacture, he might say that there was nothing in the process noxious in any way. There were no sulphur compounds except suphuretted hydrogen, which existed in a small proportion, and which he at once removed by oxide of iron purifiers. The question as to the adoption or this apparatus in houses, had already been answered by the Chairman. It was certainly not his intention to recommend anything of the kind; but in large institutions, factories, and isolated buildings, it certainly had a field of operation. In towns, if it came to be applied at some future day, it would no doubt be taken from some central point of manufacture and be distributed. The principal point raised, perhaps, was the last, with reference to the presence of carbonic oxide in the gas, and of course he had not overlooked it. They all knew that carbonic oxide was a harmful gas, but they did not, perhaps, remember that ordinary coal gas contained from eight to nine per cent. of it. In his gas there was about three times that amount, It was, therefore, mixed with other gases, and with ordinary precautions, there need be no trouble about it. He had been working with the gas for about five years, and had had no mishap—of course, taking due precautions. On the other hand, you had to provide for carelessness, and certainly ought to provide for its having a characteristic smell, in order to ensure detection, and that could be readily done. For engine work, or for any purpose where it was taken direct from the producer to the place of consumption, there was no need for any special treatment to give it a smell, but where it was to be distributed in houses, or anything of that kind, there were many substances which might be used for that purpose. It was very simple to pass it through a vessel containing sublimated napthaline, a very little of which was taken up by the gas, but quite sufficient to give it a characteristic smell.

ADDITIONS TO THE EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

The following have been received since the publication of the catalogue:—

35. Addition to Mr. Warnerke's exhibit, consisting of specimens showing the applications of his new gelatine films.

50. Hart, F. W., 8, Kingsland-green, E.:—
Burnisher constructed in 1853.

52. Morgan & Kidd, Helio-house Studio, Circus, Greenwich:—
Enlargements on gelatino-bromide paper.

53. White, Lieut., R. W., H.M.S. *Polyphemus*, Chatham:—
Photographs of torpedo explosions.

77. Gladstone, Dr. J. H., F.R.S., 17, Pembridge-square, W.:—
Photographs of fluorescent substances exhibited at the British Association meetings in 1859 and 1873.

(1.) Photograph of designs in quinine, chlorophyll, stramonium, and comenamate of potash. 1859.

(2.) Photograph of white letters covered with different fluorescent substances, pasted on blue paper; the blue paper comes out white, the white letters dark. 1859.

(3.) Photograph of glasses containing respectively, ink, water, and bisulphate of quinine. The fluorescent solution has no more effect than the ink. 1873.

(4.) Photographs of test-tubes with ink, water, and various fluorescent solutions. 1873.

(5.) Experimental proof that the darkness of the quinine salt is not due to changes in the white surface of the paper.

Micro-photograph of the first page of the *Times* of the 18th January, 1873, as used in the "Pigeon Post" at the Siege of Paris.

78. Swan, J. W., Mosley-street, Newcastle-upon-Tyne:—
Biaxial electric lamp and switch for photographers' use.

99. Hill, J. Pearson, Hampstead, N.W.:—
Daguerreotype of the Dome of the Invalides, Paris, purchased by the late Sir Rowland Hill, in 1839, for fifty francs.

Miscellaneous.

SARDINE FISHERY.

The sardine fishery constitutes, in France, a maritime industry, which plays a considerable part in the prosperity of the littoral population. The port of Douarnenez alone possesses 800 fishing-boats of seven or eight tons; and Concarneau, 600; while there are another 600 boats between Brest and Sables d'Olonne. The crew consists of the master, three men, and a boy, making, in all, 25,000 to 30,000 persons engaged in the sardine fishery, while the preservation of the fish affords work to at least an equal number. In 1875, Douarnenez produced 1,325 tons of green-salted sardines, sold as fresh fish. The boats—20 feet long—are flat in the stern, but raised and pointed at the prow, which gives them great speed, though it exposes them to the danger of capsizing. They have two masts slightly inclined backwards, and square sails of large size, which permit them to take advantage of the slightest breeze. The nets, not weighted with lead, are from 20 to 30 metres long, by 6 or 8 wide, made of very fine cord, with meshes of such size that the sardine is caught by the gills. The upper part is floated with corks, which serve to maintain the vertical position of the net.

In the sardine fishery, the bait, which is called *rogue*, plays the principal part. It is a kind of caviare, made from the eggs of the cod preserved in brine, 35,000 barrels of which, representing a value of £70,000, are imported from Norway yearly. There are various indications of the presence of the sardines, floating wreck being a good sign. Large fish, which prey upon them, effect such destruction, that the escaping oil frequently rises to the surface, and exhales an odour which is perceptible by experienced fishermen. But it is especially the birds hovering round that are the harbingers of a good take. When a gull dips his beak into the water, it is a sign that the sardines are on the surface; and when a kind of gannet, common on the coast of Brittany, dives down from a height, they are at a certain depth below the surface. In this case, the nets are at once let down; and the bait, mixed with sand, to cause it to sink, is scattered by the master. If the bait causes the sardines to rise, a few emerald-green flashes appear in the waves, when the fisherman do not spare the bait; and presently the whole shoal rises round the nets. When there are no more fish to be taken, the nets are hauled in, the sardines are taken out and thrown into the hold, and the boats make for shore.

Formerly, a single boat could take as many as 20,000 sardines, but now it is rare to bring in more than from 5,000 to 6,000. The results vary, not only from year to year, but also between two neighbouring points on the shore. According to a table prepared by M. Gouillon, there were, at Douarnenez, from 1859 to 1872, three years of good, six years of average, and three years of poor takings.

On landing, the sardines are taken from the boats to the factories in hampers containing about 500, and the preparation begins at once with perfectly fresh sardines. Women cut off the heads, open and clean the fish, and place them, one by one, on stone or marble slabs previously strewed with salt. While this preliminary drying takes place, the fires are lighted, and the purest olive oil is put into immense cauldrons. When the oil is in a state of ebullition, the sardines are laid in layers in iron wire baskets provided with handles. These baskets are plunged into the boiling oil, and then placed on shelves covered with sheet zinc to drain, the oil being caught for future use. The fish, when moderately dry, are taken to the large drying-house exposed to the sea breeze, where they remain for a longer or shorter period, according to the state of the atmosphere. On leaving it, they are sorted and put into boxes; the largest are considered as of first quality, while the small are frequently metamorphosed into anchovies.

NOTES ON THE PRODUCTION OF PUMICE-STONE IN THE ISLAND OF LIPARI.

Messrs. Toso and Baldacci, engineers in the Royal Corps of Mines, have published the following particulars on the production of pumice-stone in the Island of Lipari. This substance is found chiefly in the northern parts of the island, on the slopes of the mountains, called Punta della Castagna, Monte Pelato and Monte Chirica, which appears to have formed part of a great crater, formed of inclined layers of stones and ashes from volcanic eruptions. The stratum containing the pumice-stone is covered with a layer of stones, in some cases reaching 40 yards in thickness, and being of a light grey colour, gives a singular aspect to the landscape. These deposits are usually worked by an inclined gallery driven in the hill-side at right angle to the dip; from the bottom of this, a level 6 feet by 6 feet is driven along the strike, and, from this, other galleries are driven at intervals following the inclination of the stratum. When one of the galleries has reached the boundary of the workings, it is filled up with rubbish to within 18 inches of the top, and another gallery about 8 feet wide by 6 feet high is commenced parallel to first, leaving a sufficient thickness of material as support for roof. When all the lower portion of this deposit has been worked away, a slice above 6 feet in height is removed in the same way, and this operation is continued until the roof of this deposit is reached. The pumice-stone is brought to surface on men's backs, the miners taking in turns the excavations and transport of the material. The workings are usually carried on by eight or ten miners, who, at the end of their day's work, divide the pumice-stone obtained, and carry it down to the village of Canneto, where the principal dealers reside.

About 240 miners are engaged in this industry, and produce about 25 tons per annum per man. The deposits of pumice-stone chiefly belong to the Commune, which levies a duty of 3·25 lire per ton on all exported from this island. Some of the workings belong to private individuals, in which case the miners pay a small royalty.

The sorting and preparation of this material is carried on at Canneto, and is classified according to quality, the best of which is sold at Messina at £40 per ton, whilst the inferior qualities fetch from 25s. to 30s. per ton. There are also mills at Canneto, and here quantities of ground pumice-stone are obtained. About 6,000 tons is annually exported, which, at an average value of 70 lire per ton, represents 420,000 lire (£16,800).

NEW ZEALAND FUNGUS.

Consul Griffin, of Auckland, states that among the various products of New Zealand, that of fungus has, within the last few years, attracted a considerable amount of public attention. It was not deemed of sufficient importance to be included in the list of colonial exports until 1872, but since that year the annual shipments have steadily increased. The export of New Zealand fungus appears to be confined to one species, the *Hirneola polytricha*, although there are some very rare varieties, bearing a close resemblance to it, found in the neighbourhood of Christchurch and Wellington, specimens of which were sent to the Vienna Exhibition, under the name of Jew's-ear fungus; these specimens may be easily distinguished from the *Hirneola polytricha* by the colour, the former being of a pinkish tint, while the latter is of a greyish hue. The inside of the leaf of the *Hirneola polytricha*, when dried, is a dark reddish-brown, while the outside presents glossy grey or dove colour; the leaf is shaped like a saucer, and varies in size from three to seven inches in diameter. It is flabby in appearance, rough to the touch, and of considerable strength. This fungus is found upon various kinds of decayed timber in the North Island, in what are called new bush settlements. It is more abundant in damp localities, and is very plentiful on the east coast, south of the East Cape, but it exists in the greatest abundance in the province of Taranaki. This province is about 80 miles long and 70 broad. It is bounded on the north by the River Mokan, on the west and south by the sea, and on the east by a straight line from the mouth of the Patea River to a bend in the Wanganui River, and by another straight line connecting the latter river with the source of the Mokan. Within this region are vast forests; in fact, not more than one-tenth of the entire province is composed of open land. The process of clearing the ground is very slow, and the settlers often find their task so difficult that they abandon their work in one place and begin again in another. They lop off the branches of the trees and burn them, leaving the logs upon the ground, and these soon begin to decay. The trees are well supplied with spurs, and fall in such a way as to partially rest upon them within a few feet of the ground. Sometimes the workmen erect scaffolds for the trees to fall upon. It is supposed that the trees being left in this way favour the growth of fungus. It appears that very little trouble, and no expense, is required to prepare this valuable article of commerce for the market, the only thing necessary being to gather it and spread it out on the ground in the open air, or under sheds to dry. This is generally done by children, who make a good living in collecting it. Very few men, except those of idle and dissipated habits, engage in the employment of collecting fungus, with the exception of the Maories. The fungus collected by the natives is generally dried in smoky huts, and is on that account not so valuable as that prepared by Europeans. As soon as it is dried, it is put in flax baskets or jute bags, and sold to the dealer. It is then packed in bales, and shipped to China by way of Sydney or San Francisco. Some of it goes direct to San Francisco, where it is either transhipped to China or consumed by the Chinese population of the Pacific coast. At one time, the profit upon fungus was very great, as it could be bought from the collectors at little more than a halfpenny per pound, and sold in San Francisco at sevenpence-halfpenny, and about a shilling in Hong-Kong; but now that its market value has become better known, it is difficult to purchase it in New Zealand, even in small lots, from the collectors, for less than fourpence to fivepence per pound. In 1873, the New Zealand Government caused an inquiry to be made as to the purpose for which fungus is used in China; and it appeared, from the Report of the Colonial Secretary of Hong-Kong, that the article was much prized by the Chinese community, as a medicine administered in the shape of a decoction to purify the blood, and also as an article of food, as it forms the chief ingredient of their favourite soup, it being much prized on account of its gelatinous properties, and its rich and delicious flavour. It is also used in China and Japan for making a valuable dye for silks.

CULTIVATION OF THE SHUMAC TREE IN ITALY.

The leaves of the shumac tree are extensively used throughout Europe for tanning purposes, and a large amount of care and attention is expended on the cultivation of the tree in Italy, with considerable profit to the planters. It thrives best in Southern exposures and hot temperature; its life is from twenty-five to fifty years, according to the conditions of the ground, climate, and culture. It spreads through shoots rising from the bottom of the tree, and it is for this reason that plants two or three years old are selected for transplanting; the price for which they are to be obtained in Italy is 50 centimes per 100. In preparing a shumac plantation, ditches are dug in the ground about three feet three inches apart, with a breadth and depth of about 17 inches. In stony ground the plant is set in holes, the shoots are placed at a distance of about three feet from each other, so that every hectare (2½ acres) will have 10,000 trees. In digging the ditches, and more especially the holes, great care is always taken to prevent water remaining in the bottom, and when there are no other means to provide against it, the ground is cut transversely. The tree does not flourish in heavy or damp ground, especially when the substratum is impermeable. The plantation is made in December, and then, during the first year, the ground is dug up from four to six times, to preserve it from weeds; manure is but sparingly used. The first digging, which is the deepest, is made in January, and the following in March, May, June, August, and October. In September of the first year, the leaves are stripped off with the hands, a little before their falling. It is better, however, not to touch the young bark, but to allow them to fall off naturally. Young trees are sometimes too quickly stripped and damaged, while the crop of leaves will bring, when sold, half the price of that obtained in the following years, in which the shumac ground is dug over more frequently; this is done between December and January, and March and May, when the earth is heaped up round the stem, at the time of the first digging, and then smoothed down. In Sicily, they heap up the earth among plants, cultivated as vines, to ventilate it by increasing the surface through hills, to make the running off of water easy, and to facilitate the future transplantings. In the time of the greatest dryness the hills are always levelled. In the second year, open spaces left by dead plants are filled up. The harvest is made when the leaves have acquired all their development and consistency, and are about to change colour; it takes place between July and August, yet before the month of May the leaves of the lower branches grow yellow, and fall, and these are also gathered. Usually, in collecting the crops, secondary branches are cut off, leaving only the trunk of the tree for the new buds. Some planters strip off the leaves by hand in July, and lop the trees in December, but this has the disadvantage of causing the new buds to grow too soft and the leaves too flabby. The branches are either left in bundles on the ground, for two or three days, after which they are carried to the threshing-floor; or they are brought at once to the threshing-floor, where, after two or three days, according to the season, they are ready for threshing, and are beaten out with flails, or by means of horses. When beaten with flails, the twig is fairer and less torn, and is sold in bales, but when trodden out by horses, it is crushed into minute particles before it is exposed for sale. When long leaves are required for the bales, the bales are threshed early in the morning, before the heat of the day has dried up the leaves; but for crushing, the operation must be done in the hottest hours, when the branches already threshed once are threshed again. Square linen sheets, six feet square, with a ring in each corner, to pass a rope through, are generally used for carrying the dried branches and leaves to the storehouse. The leaves for bales are carried to the storehouses, and the rest to the mill, which is similar to that used for olives. After being ground, the large lumps are sifted out, and the branches and other impurities thrown away, and the leaves, if any, are ground again. In this work, the leaf loses a seventh part of its original weight. The threshing-floor is always kept in good condition, paved and covered with cement or bricks, and the storehouse is generally exposed to the sun. When the shumac becomes old, and its verdure scanty, another crop is cultivated, and for this the vineyard is especially adapted by the previous preparation.

POISONOUS SUBSTANCES FOR COLOURING FOOD.

The Prefect of Police, Paris, has expressly forbidden confectioners, distillers, grocers, and shopkeepers generally, to use for colouring sweetmeats, liqueurs, and alimentary substances, any of the following matters:—

Mineral Colours.—The compounds of copper—blue verdegris, mountain blue. Compounds of lead—oxides of lead—massicot and minium. Oxychloride of lead—Cassel yellow, Turkey yellow, Paris yellow. Carbonate of lead—white lead, flake white. Antimoniate of lead—Naples yellow, Sulphate of lead. Chromates of lead, chrome yellow, Cologne yellow. Chromate of baryta—yellow ultramarine. Compounds of arsenic — arsenite of copper, Scheele's green, Schweinfurth green. Sulphide of mercury—vermillion.

Organic Colours.—Gamboge and Naples aconite. Fuchsine and its sub-products, such as Lyons blue. Eosine. Nitro derivatives, such as naphtol yellow and Victoria yellow.

It is also expressly forbidden to make use of any of the above-named substances for colouring the paper used for wrapping up any article of food. Both manufacturers and dealers are held personally responsible for accidents which may occur from the use of alimentary substances, or from wrapping paper coloured with any of the above-mentioned matters. Manufactories and shops are to be inspected annually, or more frequently, if deemed necessary, so as to ensure the observance of these regulations. Infractions will be dealt with according to law, before the competent tribunals. The chief of the municipal police, the mayors, the commissaries of police, the inspector-general of wholesale and retail markets, the head of the chemical laboratory, and others whom it may concern, are charged with carrying the measure into effect.

LADIES' SANITARY ASSOCIATION.

A third series of nine lectures on "Domestic Sanitation," will be delivered by Dr. B. W. Richardson, F.R.S., in the Lower-hall, Exeter-hall, Strand, during March, April, and May. The course is a continuation of the series of lectures on food and digestion, and the nervous system, delivered in the spring and autumn of 1881. The first lecture will be delivered on Saturday, March 4th, at 4 p.m., and the course will be continued on the same day of the week, and at the same hour, with the exception of Easter vacation, until May 13.

Tickets for the course: One guinea (transferable). Single Tickets: Reserved seats, 2s. 6d., to be obtained from the secretary, Miss Rose Adams, at the office of the association, 22, Berners-street, W. Unreserved seats, 1s., by payment at the door.

Prizes will be awarded to the most proficient students of either sex, as follows:—First prize, of ten guineas, given by Edwin Chadwick, C.B.; second prize, of five guineas, given by Mr. George Leon; third prize, of three guineas, given by Miss Marshall; fourth prize, of two guineas, given by Mrs. B. W. Richardson; fifth prize, of one guinea, given by The Lady Sudeley; sixth prize, of one guinea, given by Mrs. Geo. Cruickshanks. Certificates of first and second-class merit will also be awarded.

Correspondence.

STAINED GLASS WINDOWS.

I shoul dlike to say a few words in reply to the remarks made on my paper by your correspondents of last week.

I made no allusion to glass in the 7th century, for the simple reason that I confined myself to the art of glass-painting, and that we have no remains of old glass that date back to anything like that conjectural period of our history. I am sorry that Mr. Mitchell does not "like" my reference to the "trumpery decorations of wax and tinsel, and paper flowers that desecrate the altars abroad." He has been several years abroad, and never saw them. I go annually, once or twice, on the Continent, for a month or so, and always see them. Many a time I have travelled miles in search of old glass, and have found it half hidden by some temporary erection of drapery or or false flowers, altogether beneath contempt. Mr. Mitchell may perhaps fancy that my remarks were suggested by some antipathy to the Romish church; but I assure him, that is not so. My contempt is only for the persons who proffer shame to their patron saints, and thereby, as it seems to me, desecrate the altars.

Mr. Laing is quite right in opining that it would not have been difficult for me to mention some English glass-painters whose works now speak for themselves. There are two reasons why I did not do so. Any praise bestowed upon men whose names were not familiar, might have been set down to personal friendship, and any censure of men of high standing, to "envy, hatred, and malice." Moreover, I could not have referred to some of the ablest artists in glass, without adding that their art appears now for some years past to have been fast degenerating into mere manufacture.

LEWIS F. DAY.

13, Mecklenburg-square, W.C.
Feb. 20th, 1882.

General Notes.

POSTAL PARCELS IN FRANCE.—Since 1st May, 1881, as the result of a convention between the French Minister of Posts and Telegraphs and the administrations of the various railways in France, parcels not exceeding 3 kilogrammes (6½lbs.) in weight, and subject to certain limits of dimensions, are conveyed between any two points of French territory for 60 centimes (6d.), if called for at the station, and for 85 centimes (8½d.) if delivered. These rates include the duty of 10 centimes (1d.) levied by the Government.

ROSE CULTURE.—The Kezanlik Valley, in Roumania, is entirely given up to the cultivation of roses. The essence is sold wholesale in Paris from £30 to £40 per lb., while it is retailed at £100 or more per lb.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

MARCH 1.—"The Teaching of Forestry." By Colonel G. F. PEARSON. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., will preside.

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S.

MARCH 15.—"Gas for Lighthouses." (Illustrated by an Exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM. Prof. TYNDALL, F.R.S., will preside.

MARCH 22.—"Telephonic Communication." By LIEUT.-COL. C. E. WEBBER. The Earl of CRAWFORD AND BALCARRES, F.R.S., will preside.

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A. Dr. W. J. RUSSELL, F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 28.—"Scientific and Technical Education in Russia." By Professor F. HODGETTS, of the Imperial College of Practical Science of Moscow.

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

APRIL 21.—"The Mineral Resources of India, and their Developments." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Third Course will be on "Hydraulic Machinery," by Prof. JOHN PERRY.

LECTURE I.—MARCH 6.

The hydraulic press. The nature of fluid pressure. Compressibility of water. The law of work in machines. Hydraulic jacks, punches, shears and rivetting machines. Pressing machinery. The influence of friction. Bursting pressures.

LECTURE II.—MARCH 13.

Water at rest and water in motion. The energy law. Gauge notches. Centrifugal pumps and fans. Flow of water in pipes. Steam pumps and other reciprocating pumps.

LECTURE III.—MARCH 20.

Water-wheels and pressure-engines. Turbines. Measurement of the horse-power given out. Loss of power by friction. Hydraulic fittings, pipes, valves, &c. Accumulators, cranes, and hoists.

LECTURE IV.—MARCH 27.

Lifts. The new balance method, as applied in bridges, canal boat, and other lifts. The transmission of power to machines at a distance by means of water. Applications to various tools. Comparison of hydraulic and electrical methods, and the part which each is likely to play in the future.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 27....Royal Geographical, University of London Burlington-gardens, W., 8½ p.m. Major J. E. Sandeman, "Recent Exploration of the Sources of the Irrawaddy."

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. 1. Mr. George F. Hardy, "An Improved Method of Approximating to the Value of Annuities involving Three or more Lives." 2. "The Valuation of Policies subject to Half-yearly and Quarterly Premiums." (Being an extract from a Joint Report by Messrs. Thos. B. Sprague and George King.) 3. Mr. George F. Hardy, "The Rate of Interest in Annuities-Certain."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Prof. A. H. Sayce, "The Gods of Canaan."

Surveyors' Institution, 12, Great George-street, Westminster, S.W., 8 p.m. Mr. J. E. Bankes, "Distress for Rent."

TUESDAY, FEB. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Professor J. F. Hodgetts, "Scientific and Technical Education in Russia."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. G. McKendrick, "The Mechanism of the Senses." (Lecture VII.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Ewing Matheson. "Steel for Structures."

WEDNESDAY, MARCH 1....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Colonel G. F. Pearson, "The Teaching of Forestry."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. J. C. Thresh, "Further Contributions to the Chemistry of the Rhizome of Zingiber Officinalis." 2. Mr. E. L. Cleaver and Mr. W. Williams, "Note on Extract of Aconite and on the Alkaloid of Aconitum Paniculatum."

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. W. H. Cope, "Ancient Ecclesiastical Glass Painting." Roman Villa recently discovered at Methwold, Norfolk."

Obstetrical, 53, Berners-street, Oxford-street, W. 8 p.m.

THURSDAY, MARCH 2...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. H. Perkin, "The luminous incomplete combustion of Ether and other bodies at temperatures below redness." 2. Mr F. R. Japp and Mr. F. W. Streatfield, "The Action of Aldehyde on Phenanthraquinone in presence of Ammonia." 3. Mr. F. R. Japp and Mr. F. W. Streatfield, "Application of the Aldehyde and Ammonia Reaction in determining the Constitution of Quinones."

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. W. E. Ayrton, "The Storage of Power."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. L. Sclater, "The Geographical Distribution of Animals." (Lecture III.)

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Prof. Kerr, "The Condition of the Air within our Houses."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, MARCH 3...Royal United Service Institute, Whitehall-yard, 3 p.m. Sir Thomas Brassey, "A Review of the Ship Building and Arming Policy of the Last Five Years, at Home and Abroad."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. A. Tylor, "Roman Antiquities in London."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Paper by Mr. Henry Sweet.

Royal College of Physicials, Pall-mall East, S.W., 5 p.m. (Gulstonian lectures.) "Pulmonary Cavities, their Origin, Growth, and Repair." (Lecture I.)

SATURDAY, MARCH 4....Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Watkiss Lloyd, "The Iliad and Odyssey." (Lecture III.)

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FRIDAY, MARCH 3, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SOCIETY OF ARTS' PATENT BILL.

Sir John Lubbock, Bart., F.R.S., M.P. (lately a Vice-President of the Society), has consented to introduce the Society's Patent Bill to the House of Commons.

MR. BAX'S BEQUEST.

The Council have to announce the receipt of a legacy of £100, less legacy duty, left to the Society under the will of the late Mr. Edward Bax, who was a member of the Society from 1850 to 1881, the year of his death.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, February 23rd, 1882; Dr. A. W. Williamson, F.R.S., in the chair.

The paper read was on—

METHODS AND STANDARDS OF PHOTOMETRY.

By Harold B. Dixon, M.A.

Millard Lecturer in Chemistry at Trinity and Balliol Colleges, Oxford.

In the study of both heat and light we have to distinguish two quantities—intensity and total amount. In the measurement of heat, we are concerned sometimes with the intensity of heat in a body, or its temperature, at other times with the total amount of heat contained by the body. Similarly, in the measurement of light, we may have to determine one of two quantities—first, the intensity or intrinsic brightness of the light; secondly, the total amount of light emitted. The intrinsic brightness of the electric arc far exceeds that of any flame we can produce, but a gas flame with less intensity than the arc may be made to give a better illumination by reason of the great magnitude of its radiating surface. In estimating the value of any source of light—such as an oil lamp, a gas flame, or a candle—what we are generally most concerned with is the total quantity of light it gives for a given consumption of fuel; in other words, we want to know, when we purchase an illuminant, how bright it will make our rooms, and how long it will last. The intrinsic brightness of the flame, apart from its illuminating power, is but a secondary consideration.

The sensations of radiant heat and light we experience when we stand in front of a coal-fire, are produced by the impact of ethereal waves upon our nerves. The red-hot coal is composed of a number of molecules thrown into a state of intense vibration, by the chemical action going on between the air and the surface of the coal. These vibrations are communicated to the sea of ether pervading all space, and are transmitted to a distance as ethereal waves, just as the vibrations of a tuning-fork are communicated to the surrounding air, and are transmitted to a distance as aerial waves. As we stand in front of a fire, these ethereal waves beat upon us, and produce sensations of warmth and light. As the fire dies down, our sensations of warmth and light become feebler; but they do not disappear together. Long after we have ceased to be conscious of any light, we can feel radiant heat streaming from the ashes. On the other hand, the full moon at night gives us the sensation of bright light, unaccompanied by any feeling of warmth. Yet the ethereal waves which produce these two sensations differ not in kind, but only in degree. Their undulatory nature is the same, their rate of motion is the same; but some are packed closer together than others, so that they differ in the rapidity with which they succeed one another, and strike upon our senses. Those which succeed one another at short intervals are called short waves, those which follow one another at longer intervals are called long waves.

The total radiant energy of a hot luminous body can be accurately measured by completely surrounding it with a water-jacket, and observing the increase in temperature which the water undergoes in a given time. The ethereal pulsations of every wave-length, radiating from the hot body, are absorbed by the surrounding water, whose molecules take up the vibrations, and are thus set swinging more briskly. This increase of molecular motion in the mass of water can be measured by a thermometer plunged in it. To raise one gramme of water in temperature through one degree, one unit of radiant energy is necessary. If, therefore, we know the mass of the water, and we observe the number of degrees through which its temperature is raised in a given time, we have all the data required for calculating the total radiant energy of the hot body. But such an apparatus would not help us to determine the light emitted by a flame apart from the heat. Of the infinite number of waves of different lengths emitted by a white hot body, only a certain few are capable of exciting sensation in the human eye. When the crests of the waves of ether, beating on the eye, are more or less than a certain distance apart, we have no sensation of light. The longest waves that can excite vision give us the sensation of red, the shortest waves give us the sensation of violet. Waves of intermediate length give us the sensation of the other colours of the spectrum—yellow, green, and blue. When waves of all these lengths fall upon the eye in due proportion, we get the compound sensation we call white light. The eye is sensitive to ethereal pulsations only over a very small range. Waves of greater length than those which give us the sensation of red, and waves of less length than those which give us the sensation of violet, produce no sensation of light at all. Since the extreme violet waves are about half as long as the extreme red waves, the compass of our vision is very small compared with our audition, for it extends over a range corresponding with barely one octave.

Several attempts have been made to devise an instrument which should measure the heat produced in the absorption of only that particular set of ethereal waves which affects the eye. Leslie endeavoured to measure the energy of the waves that excite vision, apart from the energy of the longer or shorter waves, by receiving the radiations from a luminous body on the bulbs of a differential thermometer, one of the bulbs being of transparent glass, and the other coated with lampblack. His idea was, that the long heat waves would be absorbed by both bulbs equally, but that the blackened bulb would absorb the light-producing waves as well, and so become hotter than the transparent bulb, which would allow them to pass through it unabsorbed. But, as Leslie himself proved, lampblack is a better absorber of heat waves than clear glass, so that the depression of the liquid in the tube connected with the blackened bulb is not to be wholly, or even mainly, attributed to the light absorbed.

Another and better attempt was made by Ritchie in 1825. The bulbs of his differential thermometer were composed of closed metallic vessels, with one thick glass plate side. Inside each vessel a piece of blackened paper was hung so as to intercept the rays which entered through the glass plate. The two vessels were placed side by side, these glass faces being turned in opposite directions, and one of the lights to be compared was moved nearer or further away from the photometer, till the liquid in the bent tube connecting the vessels stood at the same height in both arms. Then, if only those rays which produce the sensation of light could pass through the glass plates, and if they were all converted by the blackened paper into heat, the instrument would give a correct measurement of the relative quantity of light rays falling on the two bulbs; but it would not necessarily inform us which of the two lights would appear the brighter to our eyes. For unless it could be proved that our sensation of brightness varies directly with the quantity of luminous rays which fall upon the eye, and is independent of their wave-length or colour, it might happen that two different sources of light might give out light rays which, converted into heat, would equally affect the two bulbs of the thermometer, and yet might differ in illuminating power, owing to our eyes being more sensitive to the rays of one, than to the rays of the other. But however this may be, it certainly is not the case that only those rays which excite vision can pass through glass, and, therefore, Ritchie's instrument does not fulfil the first condition of a photometer.

A similar objection applies to many other methods of determining indirectly the illuminating power of a source of light. There have been devised excellent means of measuring the amount of chemical or physical change produced by the action of light on certain substances, such as the darkening of silver salts, the combination of hydrogen with chlorine, the decomposition of hydrogen iodide, and the alteration in the electric conductivity of selenium; but such measurements are not determinations of illuminating power, but of certain portions of the total radiant energy of a luminous body, which include more or less completely the rays that excite our vision.

Since, therefore, the object aimed at in photometry is the measurement of the effect produced on our eyes by any source of light, it is essential that the eye should be used to receive the rays; and since it is impossible to remember at all accurately, even for a short time, the effect produced on our eyes by any source of light, it is also essential that we should have a constant standard of light, with which to compare other sources of light directly. The production of a standard of illuminating power, with which other illuminants can be compared, and the mode of such comparison, are the two problems in photometry to which I desire to draw your attention.

The official standard used in England at the present time is a sperm candle of six to the pound. This is the standard prescribed by the Metropolis Gas Act of 1860 for testing coal-gas. Later Acts, and the notifications of the gas referees, contain detailed instructions as to the proper mode of employing the candles; the candle must be cut in half and lighted in the middle, so that, while one half burns down to the thicker end, the other half burns down to the thinner end; the candles must have been burning fifteen minutes before the testing begins, so that they may have assumed their normal rate of burning; the candles must be weighed before and after each testing, and only those candles that burn more than 114 grains and less than 126 grains of sperm per hour are to be considered as standard candles, and a correction is to be made, when the consumption of sperm falls within these limits, on the assumption that the light emitted by the candles varies directly with the sperm consumed. But in spite of these precautions, great discrepancies have been obtained by careful operators using sperm candles as a standard of light. On this occasion I can do no more than refer to the experiments of other chemists on sperm candles, among which the ingeniously devised observations of Messrs. Kirkham and Sugg, and the long series of determinations made by Mr. Vernon Harcourt, occupy the most prominent place. In consequence of Mr. Harcourt's results, the Board of Trade, in 1879, appointed a committee to investigate the alleged untrustworthiness of the candle standard, and to examine and report upon three proposed standards—(1st) The sperm oil-lamp of Messrs. Keates and Sugg; (2nd) the gas-burner of Mr. J. Methven; and (3rd) the air-gas flame of Mr. Vernon Harcourt. This committee was composed of Dr. A. W. Williamson, Dr. Odling, and Mr. George Livesey. I had the honour of being appointed secretary to the committee, under whose direction I conducted the experiments I propose to recount briefly to the Society.

For our standard of light we employed coal gas, stored specially for our use by Mr. Livesey, in a large gas-holder, at the South Metropolitan Gas Works. We found that the iluminating power of this coal gas remained remarkably constant for a lengthened period, and, therefore, was well adapted for our purpose. In the first place, candles of slightly different make, but coming under the Parliamentary definition of "six to the pound, and burning 120 grains per hour," were obtained from the London firms who manufacture sperm candles of the kind prescribed by the Acts, and these candles were compared in an open and also in a closed photometer, with the stored coal gas. The results have been condensed in the following Table, which gives the average obtained with each variety of sperm candle tested:—

AVERAGE RESULTS.

Maker.	Threads in each strand.	Average consumption of Sperm per hr.	Illuminating power attributed to coal gas.	Relative illuminating power of candles.
Miller	21	112·6	18·42	94·3
,,	18, 18, 19	110·1	17·37	100
,,	21	115·8	19·18	90·6
Langton and Bicknell	18	116·6	18·35	94·7
Ogleby	21, 22, 23	132·6	19·0	91·4

Taking the first two sets of figures, we see that the average illuminating power of one variety of Miller's sperm candles is more than 5 per cent. greater than the illuminating power of a second variety of the same maker's candles, which only differs from the first in the number of threads in the strands of the wick. Looking at the individual testings made, we find that the illuminating power of the stored coal gas is given on one day as 16·0 candles, by one pair of candles, and as 18·5 by another pair; while on another day the illuminating power of the stored coal gas is given as 17·1 candles by one pair of candles, and as 19·5 by another.

In order further to test the variations of sperm candles, the committee had a photometer fitted to burn candles at both ends, which were made exactly similar in all respects. Each pair of candles was weighed before and after the experiment, and a corresponding correction was made in comparing their illuminating power for the sperm consumed. Each experiment consisted in taking ten observations at intervals of a minute. The following Table contains the corrected results, the illuminating power of the less bright of the two pairs of candles tested being called 100 in every case:—

The letters A, B, &c., represent different varieties of candles, he figures following different candles.

	Illuminating Power.			Illuminating Power.
A. 1 =	100	when	A. 2 =	101·6
A. 3 =	100	when	A. 2 =	101·6
A. 3 =	100	when	A. 2 =	101·5
A. 3 =	100	when	A. 4 =	102-5
A. 4 =	100	when	A. 5 =	101·3
A. 6 =	100	when	A. 5 =	105·6
A. 6 =	100	when	A. 5 =	109·2
A. 6 =	100	when	B. 1 =	109·4
B. 1 =	100	when	B. 2 =	105·4
B. 3 =	100	when	B. 2 =	107·4
B. 3 =	100	when	B. 4 =	102·2
A. 7 =	100	when	B. 4 =	105·6
A. 7 =	100	when	A. 8 =	102·8
A. 8 =	100	when	C. 1 =	100·5
C. 1 =	100	when	C. 2 =	105·1
C. 2 =	100	when	B. 5 =	111·7
B. 5 =	100	when	B. 6 =	101·7
D. 1 =	100	when	B. 5 =	104·8
D. 1 =	100	when	D. 2 =	102·8

When the light of two pairs of sperm candles is compared directly in this way, the variations of intensity are strikingly apparent. The following are the actual readings taken every minute, in a test extending over 20 minutes, of the illuminating power of a pair of candles, the value of the other pair being assumed to be 16 in each case. The candles were from different packets, but of the same make. The highest reading is 19·2, and the lowest 16·2, a difference of more than 18 per cent, and within two minutes we find a variation of more han 12 per cent.

A. 16. Illuminating power.	A. 16. Consumption.	A. 15. Illuminating power.	A. 15. Consumption.
18·6	76 grs.	= 16	70·8 grs.
18·3			
18·7			
18·8			
18·9			
18·8			
19·2			
18·9			
18·9			
18·7			
18·2			
18·6			
18·4			
18·3			
17·9			
18·2			
17·3			
16·2			
17·5			
16·7			
18·25 mean.			

A. 16. *v.* A. 15.

$$\text{A. } 15 = 100$$

$$\text{A. } 16 = 100 \times \frac{18{\cdot}25 \times 70{\cdot}8}{16 \times 76} = 106{\cdot}3.$$

But the most convincing testimony against the candle standard is afforded by our third series of experiments, in which the stored coal gas was tested every day for a fortnight, with candles such as are now being supplied to the testing stations. The candles are sold in packets containing 6 lbs., or 36 candles. We found that candles out of the same packet were fairly uniform in illuminating power. But the average value of the candles from one packet differed very considerably from the average value of the candles from another packet. One packet, composed of fairly uniform candles, gave, as the average result of testings made with ten candles, the illuminating power of coal gas as 15·0, and another packet gave, as the average result of testings made with ten candles, the illuminating power of the same gas as 17·2. The following Table contains the averages of at least ten candles from each packet:—

VALUE OF STORED COAL GAS AS GIVEN BY

Date.	Standard Candles. Packet.	Standard Candles.	Air gas flame.
March 23	A.	16·19	
„ 24	B.	15·26	15·9
„ 25	B.		—
„ 26	B.		—
„ 27	C.	15·21	16·05
„ 29	C.		—
„ 30	C.		—
„ 30	D.	15·25	—
„ 31	D.		15·95
April 1	E.	15·02	15·9
„ 2	F.	15·88	15.95
„ 3	G.	16·87	16·2
„ 5	H.	16·72	16·1
„ 6	I.	16·24	16·2
„ 7	K.	17·26	—
General Average		15·99	16·02

In a parallel column are printed the results of testings made with Mr. Harcourt's air-gas flame of the illuminating power of the coal gas during the fortnight these experiments lasted.

Since the report of the committee was issued, M. Giroud has published experiments made with standard sperm candles, in which he tested them against each other, and against a standard gas flame. The results he has drawn up in a series of diagrams which show the position of the screen between the two candles, and between the candle and the gas flame, at each reading of the photometer. These diagrams reveal in a striking manner the rapid alteration from minute to minute in the intensity of light of a standard sperm candle.

Count Rumford, in experimenting with his shadow photometer, discarded the candle of his day in favour of an oil-lamp, with a circular wick, as a standard of light. By means of this oil-lamp he was able to prove experimentally that the illuminating power of a source of light varies in our atmosphere inversely as the square of the distance, and therefore, that the absorption of light by several feet of air is inappreciable.

An oil-lamp, with a circular wick, burning purified colza oil at a certain rate, is used in France as the standard of light. Messrs. Keates and Sugg have introduced modifications into the French carcel lamp, and propose to employ a lamp burning pure sperm oil, with a two-inch flame, as a standard. The lamp so contrived gives a brilliant and steady light, but, unfortunately, the long wick sometimes becomes so brittle, when charred, that any adjustment of its length becomes impossible without danger of breaking it. The objections which apply to a candle as a standard, also apply, though in a less degree, to an oil-lamp. The exact nature and form of a burning wick are incapable of accurate definition, and since the illuminating power is largely dependent on the nature of the channel which supplies the combustible to the flame, no standard seems likely to be trustworthy whose constancy depends on the uniformity of a wick.

Mr. Methven has devised a plan by which he proposes to measure the illuminating power of coal gas, by cutting off a small portion from the centre of the flame of an argand burner supplied with the same coal gas as that to be tested, and using that isolated portion as the standard of light. The argand he employs is the same "London Argand" used to burn the coal gas at the testing stations. In front of the lamp, between it and the screen, a brass plate is fixed, carrying a small thin silver plate, in which a slit one inch long and a quarter of an inch wide is cut. The plate prevents any other light, except that which passes directly through the slit, from reaching the photometer. The height of the flame is adjusted as nearly as posible to three inches, though small variations in the height of the flame do not affect the quantity of light which passes through the slit. We found that there was no appreciable difference when the flame was raised or lowered a quarter of an inch from the normal height. From this description, it will be evident that Mr. Methven's method is exceedingly simple, and little or no trouble is required to prepare the standard for use. The principle on which Mr. Methven founds his method may be thus stated. When different qualities of coal gas are perfectly burnt in an Argand burner, at such rates as to yield a 3-inch flame, the central portions of such flames will be equally bright, no matter what may be the quality of the coal gas supplied to the burner. A rich gas will give a flame which begins to be luminous nearer the orifice of the burner than the flame from a poor gas; but the screen, by cutting off this lower portion of the light, equalises the two, as seen through the slit. To test the lamp, the committee conducted two series of experiments, using coal gas of different qualities to supply the Methven burner; the first series were made at the London Gas Works, the second, at the South Metropolitan Works.

The following Table gives the result of the 1st series:—

Gas used at Standard Burner.	1. 21 Candles	2. 19 Candles	3. 16·5	4. 14.
Value assigned to stored common gas	17·11	16·90	17·08	17·15
,, ,, ,,	17·08	16·89	16·92	16·93
,, ,, ,,	—	16·92	16·86	16·95
,, ,, ,,	—	—	16·92	16·99
,, ,, ,,	—	—	—	17·04
Mean	17·1	16·9	16·9	17·0

In these experiments, the two intermediate qualities of gas were prepared by mixing the cannel gas of 21 candles with air. The excellent results obtained in this series were not repeated when the lamps were supplied with varying qualities of coal gas obtained from the retorts at different periods of the distillation of ordinary coal. The rich gas used was that given off by ordinary coa during the first hour of the charge. The poor gas (13·6 candles) was made by mixing gas from the sixth hour of the charge with ordinary gas. The intermediate qualities were made by mixing the rich or the poor gas so collected with ordinary gas.

In the following Table are given the results obtained with Methven's burner, supplied with these different qualities of coal gas, and used to test the stored coal gas at the South Metropolitan Works:—

1st Set. Dec. 1880.

Value in candles of the gas burnt at the Methven burner.	13·6	14·3	14·9	15·5	15·8	16·4	17·6	19·0	19·6
Value in candles assigned to the stored coal gas.	21·2	16·6	15·6	15·2	14·9	14·5	14·6	14·5	14·0

2nd Set, with Fresh Samples of Gas. Jan. 1881.

Value of the gas burnt at the Methven burner.	14·4	15·5	16·2	17·3	18·5
Value assigned to stored coal gas	15·1	14·4	14·3	14·4	14·1

From these figures, it appears that variations in the composition of the gas may influence the light yielded by the Methven burner, and consequently some check on the Methven burner becomes necessary, in the absence of which grave errors might pass unnoticed in the estimation of a sample of coal gas. It is true that the Methven burner gives accurate results when burning the coal gas, generally sent out by the large London gas companies, and supplies a want felt by many gas managers—that of a rapid and easy method of testing their make of gas at any moment. But it is essential for a standard of light to be independent of any fluctuations in the quantities to be measured by it, and this quality the Methven burner does not possess in its present form. Mr. Methven is at present engaged in perfecting his burner, and, I believe, will shortly bring forward a lamp, better adjusted to give a constant light with varying qualities of gas.

In Mr. Harcourt's air-gas flame, the supply of combustible matter to the flame can be adjusted with extreme accuracy. An illuminating gas, especially prepared for the purpose, is burnt from a large orifice in a brass burner, at such a rate as to produce a flame 2½ inches high. All the conditions of burning are capable of exact definition. The combustible matter is a certain portion of purified American petroleum, consisting mainly of the hydro-carbon pentane. The presence of higher and lower members of the paraffin series, which occur in American petroleum, such as hexane and tetrane, does not alter the illuminating power of the air-gas prepared from pentane, when these bodies are present in such quantities, that the specific gravity of the mixture does not vary beyond certain wide limits. In practice, therefore, Mr. Harcourt does not separate pure pentane from the purified petroleum, but separates a liquid having a specified gravity closely approximating to that of pure pentane, but containing, besides pentane, some tetrane and hexane. In this way a fair proportion of standard petroleum is obtained from the crude gasoline imported into this country from New York. To try Mr. Harcourt's system, the committee first tested the stored coal gas at the South Metropolitan Works with samples of air-gas prepared from different makes of standard petroleum, using alternately, that of the highest and lowest specific gravity yielded by the process of separation. No difference could be detected in their illuminating power. Samples were next prepared and tested against the stored gas by different observers, with the same result. Then, the apparatus being set up in duplicate, one air-gas flame was tested against a second, in the same manner as candles had been tried against candles. The results, so obtained, were concordant to a surprising degree of accuracy. I give two of the sets.

1st Holder. Left-hand burner. Observations every minute.	2nd Holder. Right-hand burner.	2nd Holder. Left-hand burner. Observations every minute.	1st Holder. Right-hand burner.
(1.)		(2.)	
16·1	16	15·95	16
16·0		16·0	
16·05		16·05	
16·0		16·0	
15·95		16·05	
16·0		15·9	
16·0		15·95	
16·05		16·1	
15·95		16·0	
16·0		16·0	
Mean 16·01		Mean 16·00	

of readings taken, the illuminating power of one flame in each case being called 16, and each burner being supplied alternately from either holder.

Two objections have been raised against Mr. Harcourt's system; first, that it requires such skill and care in the operator as to unfit it for general use, and, secondly, that the meter and governor employed are on so small a scale that they cannot be made to work efficiently. In answer to the first objection, I should reply that skill and care are needed in working, but not such skill and care as cannot be found among the expert and conscientious chemists, who at present test the coal gas of the metropolis. On this point I can speak decisively. Mr. W. G. Wood, one of the official gas testers, after one day's instruction, was not only perfectly able to adjust the air-gas flame, and obtain exact readings of the value of the stored coal gas, but prepared a sample of the air gas from the standard petroleum, which gave exactly the same result as previously prepared samples. In answer to the second objection, that of the difficulty of constructing for the air-gas flame a sufficiently delicate governor and meter, an objection which has, I believe, been urged by those who make, and who therefore ought to understand them, I venture to reply that the makers under-rate their own ability, and that the accurate working meter and governor before you, consructed by Messrs. Wright & Co., is sufficient evidence to completely dispose of this objection.

The method of comparing the illuminating power of two sources of light, by observing the distances at which the two lights must be placed from the screen, so that the portions illuminated by each shall be of equal brightness, was first adopted by Bouguer in 1729. Bouguer placed his lights behind a transparent screen, so arranged that one half of it received the rays of one light only, and the other half the rays of the second light only, falling nearly perpendicularly on it. Exactly the same arrangement was afterwards adopted by Foucault in his photometer, who employed for his transparent screen two sheets of glass, pressing a uniform layer of starch between them. Rumford, in 1792, addressed to the Royal Society a description of a photometer, in which the two halves of a paper screen were severally illuminated by the rays of two lights falling at an angle of 60°. The observer sat facing the screen with the two lights behind him, one on each side. Two small wooden uprights served to protect from the rays of one light that half of the screen illuminated by the rays of the other. Each upright had attached to it a supplementary strip of wood, which, by turning the upright round, could be brought to project into the light, and so increase the width of the shadow thrown on the screen. By this arrangement, the shadows thrown by each upright could be made to accurately coincide, and the eye had less difficulty in judging when the two portions of the screen were equally bright, because they then presented one homogeneously illuminated surface. Mr. Vernon Harcourt, in his new photometer, which by his kindness I am able to exhibit for the first time this evening, has adopted a somewhat similar arrangement for his screen. The lights, as in Foucault's photometer, are placed behind the screen, which is made of ordinary printing paper, No. 23, washed with water, and painted with a solution of spermaceti in petroleum. In front of the screen, and at a distance of about $\frac{3}{4}$-inch, is placed a brass diaphragm, having two similar vertical slits cut in it, side by side, at a distance apart equal to their own breadth. The two lights to be compared are similarly placed on each side of a line drawn perpendicular to the screen. Their rays fall at such an angle that the shadow thrown on the screen, owing to the solid piece between the two slits stopping the rays of one light, is exactly illuminated by the rays of the other light passing through one of the two slits.

By adjusting the distance of the brass diaphragm from the screen, it is easy to make the shadows accurately coincide, so that when the central portion is as bright as the two outside portions, the screen presents one homogeneously illuminated surface. With this photometer, I have recently made a few experiments in Mr. Harcourt's laboratory; and I have taken from his note-book the following numbers, which represent independent tests of the illuminating power of a small sample of coal gas stored in the laboratory:—

Illuminating power of stored coal gas.	Observer.	Date.
16·5	H. B. Dixon.	Dec. 8th, 1881
16·3	A. V. Harcourt	
16·5	H. B. Dixon.	
16·4	A. V. Harcourt.	
16·5	H. B. Dixon.	
Mean 16·4		

Illuminating power of stored coal gas.	Observer.	Date.
16·5	H. B. Dixon.	Dec. 9th, 1881.
16·5	,,	
16·5	,,	
16·5	S. E. Miller.	
16·5	,,	
16·5	,,	
Mean 16·5		

In this photometer, the two lights and the disc are kept stationary, and the equality of the shadows is obtained by adjusting the coal gas supply. The photometer tells us at what rate we must burn the gas in order to obtain a flame of 16-candle power.

Bunsen was the first to employ a disc, having a portion of it made more translucent than the rest, and placed between the two lights to be compared. When such a disc is illuminated more strongly in front than behind, the translucent spot seen from the front, appears dark on a bright ground, while an observer behind the disc sees the translucent spot bright on a dark ground. When the disc is equally illuminated on both sides, the spot appears neither brighter nor darker than the rest of the disc. In the official measurement of the illuminating power of London coal gas, the Bunsen disc is employed, and either the lights are kept stationary and the disc moved, or the gas flame and disc are kept stationary, and the candles are moved until equal illumination is obtained. The distance of the two lights from the disc are then read off, and the squares of those distances give the relative illuminating power of the lights.

Since the light of a sperm candle is redder than the light of a common gas flame, it is impossible to adjust the photometer so that the two sides of the Bunsen disc appear alike. In using the Bunsen and the star disc I have generally adjusted the distances of the lights so that the circle or star appeared equally distinct on both sides, the pattern enabling one to form an idea of distinctness apart from colour. But though extremely close readings may thus be obtained with the same disc, a change of disc, or a mere reversal of the same one, occasionally introduces a considerable variation in the apparent illuminating power of the coal gas. On the whole, therefore, I consider the shadow-photometer the fairer instrument.

Another method of determining the equality of two illuminated surfaces was first proposed by Arago. When a beam of light passes through a crystal of Iceland spar it is divided into two rays, polarised at right angles one to the other, called the ordinary and the extraordinary rays. A nicol prism is formed of two pieces of Iceland spar, joined together by Canada balsam in such a way that only one of the two rays, into which the beam is divided, passes through it. Now, if the light from two equally illuminated surfaces is allowed to pass through a crystal of Iceland spar, we see four images of the two surfaces, because each beam of light is divided by the crystal. If the size and position of the illuminated surfaces are so arranged that the extraordinary image of one just coincides with the ordinary image of the other, we see three images on looking through the crystal, but the double image is, of course, brighter than the other two. The brighter image is really composed of two images, superposed one on the other, and if its two components are of equal intensity, the resulting light is ordinary unpolarised light. The other two images, composed of polarised light, will exhibit colours when examined by a thin plate of selenite, or by a plate of quartz, cut at right angles to its axis, combined with a suitable analyser. The central image will also exhibit colours, when thus examined, if its two components are not of equal intensity; for in that case there will be a surplus of one kind of plane-polarised light over and above that required to neutralise the other kind. The lights are therefore adjusted, until an observer, looking through the instrument, sees the central image white, while the two side images are coloured with complementary colours. The two lights are then of equal intensity. In this form of photometer, it is essential that the two lights should be of the same colour exactly, otherwise the colour-changes of the polarised light are valueless as indications of intensity. This objection to the instrument has prevented its adoption for testing the illuminating power of gas by comparison with a standard candle.

Several methods have lately been devised for comparing, by means of the polariscope, the intensity of corresponding portions of the spectra of two lights of different colour. Such methods give an accurate measure of the relative intensity of individual colours present in both lights, but they do not compare the total intensities. Again, by superposing such portions of one spectrum as yield a tint similar to the tint of a portion or portions of the second spectrum chosen for comparison, a nearer approach to an accurate measurement of the total intensity may be reached ; but since only some fraction and not the whole spectrum is taken, an approximation to the truth is all that can be obtained. Instead of comparing portions of the spectra of two sources of light, it is more simple to look at them through coloured glasses: in both cases only some fraction of the light is measured, and it can make little difference in the result, whether certain colours of the spectrum are cut off from the photometer by a diaphragm, or are absorbed by a coloured glass. In a small portable photometer, designed by Professors Ayrton and Perry to compare lights of very different intensity and colour, such as electric lights with a sperm candle, the brighter light, before falling on the screen, is diminished by passing through a concave lens, whose distance from the screen can be adjusted till the intensity of the more or less diverging ray is equal to that from the candle. The two shadows are compared first through ruby-red glass, and secondly through signal-green glass. Since the electric arc is comparatively richer in shorter waves than the candle flame, the shadow-comparison is more in favour of the electric arc with the green glass than with the red. Messrs. Ayrton and Perry do not give the mean result as the relative illuminating power of the arc and candle, but admitting the impossibility of truly comparing two different colours by eye, give both results as indicating the relative intensities of the two sources of light for the particular light-waves severally transmitted by the two coloured glasses.

DISCUSSION.

The CHAIRMAN said Mr. Dixon, in his most lucid discourse, had given an array of important and striking facts, but amongst them, the evidence he had given that the ordinary standard of light was so exceedingly uncertain in its value, stood out pre-eminent in importance. It struck him as being very much the same sort of thing as if one carpenter used a two-foot rule which was two or three inches longer than that used by another carpenter. In order to make comparisons of length, it was necessary to have some standard by which to compare the various lengths, and the same with regard to light; but the various standards of light presented among themselves variations equal to what he had illustrated by the familiar case of the two-foot rule; if there were sometimes 27 inches, and sometimes 24, the errors would be no greater than Mr. Dixon showed were present in the standards of light. This matter had not only very great scientific, but also immensely important practical application, and no doubt there were many gentlemen present who would be able to contribute information on the subject, or who might desire to ask questions, and he would first call on Mr. Vernon Harcourt.

Mr. VERNON HARCOURT, F.R.S., said Mr. Dixon had already so clearly described the unit of light which he had proposed as a substitute for the standard candle, that there was no need for him to give any further description of it. He should prefer to wait, and, if there were others to whom questions occurred regarding the apparatus before them, would ask leave later on to reply to them. The standard flame might be used in any kind of photometer, either the open or box photometer, or the shadow photometer, an example of which was on the table. He thought every one must agree that Mr. Dixon had given them in a comparatively short time an admirable exposition of the history and principles of photometry.

Mr. F. W. HARTLEY said in some experiments he had made, the results of which are shown in the following tables, two gases of different qualities were used in each series. The gas of lowest illuminating power is indicated by the letter A and the other by the letter B. As it was not convenient with the burner opposed to the standard flames to burn the richest gas B at the rate of five cubic feet per hour, a lower rate was adopted, which rate was constant throughout each series of tests. The value of B gas calculated to five feet rate is given under each series, but such calculated value is necessarily somewhat below the real lighting power of the B gas burned properly at five cubic feet rate, as will be understeod by photometrists. The same sample of Mr. Harcourt's air-gas was employed in all the series, and all the photometric comparisons in each series were carried completely to an end before the results were worked out and compared when the operator was far away from the testing room.

FIRST SERIES.

Candles	Illg. pr.	A.	14·80	
Air-gas	,, ,,	A.	14·16	
Methven with A.	,, ,,	A.	14·60	
Do. with B.........	,, ,,	A.	14·60	
Air-gas	,, ,,	B.		17·0
Methven with B.........	,, ,,	B.		16.94

Illuminating power B, for 5 cubic feet rate, 18 C.

SECOND SERIES.

Air-gas	Illg. pr.	A.	13.7	
Methven with A.	,, ,,	A.	13·6	
Do. with B.........	,, ,,	A.	13·6	
Air-gas	,, ,,	B.		16·05
Methven with A.	,, ,,	B.		16·80
Do. with B.	,, ,,	B.		16·68

Illuminating power B. for 5 cubic feet rate, 17·6 C.

THIRD SERIES.

Air-gas	Illg. pr.	B.	16·34
Methven with A.	,, ,,	B.	16·80
Do. with B.	,, ,,	B.	16·79

Illuminating power A. by Methven, 14 C.
,, ,, B. for 5 cubic feet rate, 18·1 C.

FOURTH SERIES.

Air-gas	Illg. pr.	A.	14·89	
Do.	,, ,,	A.	14·82	
Methven with A.	,, ,,	A.	15·24	
Do. with B.	,, ,,	A.	15·24	
Air-gas	,, ,,	B.		16·11
Methven with A.	,, ,,	B.		16·48
Do· with B.	,, ,,	B.		16·46

Illuminating power B for 5 cubic feet rate 17·5 C. The experiments, as will be seen, included gases ranging in illuminating power from 13·6 to a little over 18 candles, a difference of nearly 4½ candle, and it was found that the Methven standard with

14·6 c.	and	18· c.	gas
13·6 c.	,,	17·6 c.	,,
14·6 c.	,,	18·1 c.	,,
15·24 c.	,,	17·5 c.	,,

gave in each case almost identically the same result, the greatest difference being in the second series, between 16·8 and 16·68, or a difference of less than 8-10ths per cent. No special trouble was taken in respect to the application of this standard, but only the most ordinary care exercised. Neither are the results selected from a mass, for they follow in regular sequence, and not one in the course has been excised or made in any way to "fit in." With the exception of two instances, the air-gas indicates the power of the opposed flame to be less than the "Methven" does, striking out 16·05 for air-gas in the second series (which result may be assumed to be abnormally low), and it will be found that the per-centage differences between these two proposed standards ranges from 2·4 to 2·7 per cent. The author may add that until recently he had had no opportunity of testing the "Methven" with gas of so low a quality as 13·6 or 13·8 candle-power, the gases previously at his command ranging from something over 14 c. to considerably over 20 candles in lighting power.

Mr. J. N. SHOOLBRED said it might perhaps be interesting to mention the appropriateness of the very important paper at the present moment, inasmuch as the question of photometry was taken into serious consideration by the late International Congress of Electricians, in Paris; the result being that the subject was felt to be of so much importance, and at the same time to require so much careful consideration, that it was left to the French Government to request other Governments to name representatives, who should form an international committee for considering the question, and settle some suitable standard to be recommended for general use. The subject, however, gave rise to some very interesting discussion at the Congress, where many of the views expressed coincided generally with those of Mr. Dixon. The merit of candles, and of the Carcel lamp, were both discussed, and it was shown that both were somewhat cumbrous, and liable to error in practice. The impression generally felt, was that, in accordance with what was now the custom in most countries, a standard for practical purposes, quite as large as the Carcel lamp, should be used, if not larger. In England, the tendency was to reserve candles for theoretical purposes and for standardising, but the practical unit was a much larger one, such as a 10-candle lamp, the 16-candle lamp of Mr. Keates, or as was used by Mr. Douglass in his experiments for the Trinity-house, a lamp equal to 100 candles. At the same time the general impression amongst all scientific persons present was, that apart from this practical standard there ought to be some more purely scientific standard for regulating those standards, and that that standard ought to be composed of some substance which was readily accessible, and at the same time would preserve its qualities under the varying conditions of temperature in different countries. Some standards would act under very different conditions in St. Petersburg to what they would in the south of Europe. The general feeling was in favour of using some sort of metal, either platinum or silver; one gentleman from Marseilles proposed a platinum bar of a certain section, at a temperature just at the point of solidification, whilst M. Corner suggested that silver would be better even than platinum; the ultimate decision, however, was left to an international Commission. M. Corner pointed out some of the defects which had been mentioned with respect to the ultra-violet rays and the want of fixity of the standards, and suggested that some standard could be devised to meet those objections. With regard to the difference of colour being an obstacle to the use of polarised light as a test, Professor Helmholtz described a very simple instrument, by means of which the difficulty might be got over by using plates of mica of different thicknesses. He had some experience in comparing the electric light with gas, candles, and other lights, and wished to point out that the expression electric light was not sufficiently definite, the light from the arc and from an incandescent lamp being of a totally different colour and character.

Mr. W. J. DIBDIN said he should like to make some remarks, and he must say at the outset that he represented Mr. Keates, whose lamp met with little favour from the committee. A circumstance had happened that evening which had opened his eyes to the cause of the extraordinary results obtained by the committee at the South Metropolitan Gas Works. Mr. Dixon referred to the lamp, and would very kindly have shown it, but it was unfortunately found that it would not burn. His attention was called to it, and it was found that it could not burn, the whole of the wick having been burnt away, and only a small portion of charred remains were left round the metal wick holder. That probably was due to a little impatience on the part of the operator. It burnt a heavy oil, and required a little patience to allow the flame to rise to its normal height of two inches, and the higher he turned it the more the wick would burn, and so it would go on. It seemed to him, reading the report of the committee, that whatever had been the results obtained by the lamp it would have been condemned, because the committee did not believe in any standard in which a wick was employed, so that they evidently started on a preconceived objection to the lamp. At the close of the experiments, an invitation was sent to Mr. Keates to make any further tests, but just then a pressure of important public duties prevented that from being done; but not long afterwards a further set of experiments were made in Mr. Keates's laboratory, and the committee were invited to inspect the lamp, and make any farther tests they might think necessary. One member of the committee attended, and expressed himself pleased with the results, but the other members ignored the matter. The results then obtained were very different from those obtained by the committee. He would mention some of these results. They had not a large gas-holder at command, and, therefore, devised a standard of their own. They burnt 5·6 cubic feet of ordinary London gas in a standard burner, obtaining a high flame considerably over three inches; the top of that was cut off with a screen, so that they obtained a solid cylinder of flame three inches in height, and the appearance of the flame deviated very slightly from its normal condition. With that, as a standard, they made a number of tests on various days extending from May 28th to June 4th, of which the following were some of the results:—18·03, 17·85, 18·07, 17·99, 17·94, 17·82, 18·32, 18·21, 18·06, 18·11, 17·92, 18·13, 17·93, 17·88, 17·92, 18·05, 18·06. Those figures had rather a different complexion to the extraordinary results given in the report of the committee, which bore on their face their own condemnation by their absurdity. Their whole course of experience in the lamp extended over twelve years, and he defied anybody working with the lamp properly to obtain such results. The lamp had now been at work over a month, at Messrs. Sugg's premises, and it was open to the inspection of anyone who would like to see it or try it. One point about it was that it required a little patience to allow it to burn till the the flame attained a proper height of two inches. A large number of tests, extending over a month, were made with the lamp, candles, and other standards, and adopting the mean of a series of tests of the ordinary coal gas, taken off the main, and consumed in a standard burner, they found that the mean deviation of the lamp was ·2 of a candle. They had used, also, Methven's and other tests; there was a wonderful agreement amongst the results. Methven's gave a mean deviation of ·2, the jet of ·2, and the new 10-candle test, proposed by Mr. Sugg, only gave a deviation of ·22. The maximum deviation of the lamp was half a candle, Methven's ·9 of a candle, the jet, ·8, and 10-candle test, ·5. They had not yet been able to compare the lamp with Mr. Harcourt's test, but he had no doubt it would hold its own against any with which it had to compete.

Mr. DAVID SUGG said Mr. Hartley had given various results with Methven's test, and found it to be very satisfactory. He should say that the principles of that instrument were brought out by a German originally, and discarded by him, because the test was not trustworthy. He employed two metal cylinders, fixed on an Argand burner, with their slots, one lateral, another vertical, and by means of adjustment he could reduce or increase the power of the standard required. In the experiment he published, a gas-holder was filled with gas of a given quality, and the standard adjusted to give a light of two candles. The gas was allowed to remain in the holder until the following morning, when the standard was found to have fallen to ·2 of a candle, *i.e.*, the loss of illuminating power in storing the gas for twelve hours was sufficient to produce this change.

Mr. DIXON, in reply, said he had obtained quite as good results with Mr. Methven's standard as were obtained by Mr. Hartley. He started with coal gas of about 14 to begin with, and went on to one of about 20 candles, and got practically identical results. But though the gases tried at the London Gas Works gave these good results, yet with a different kind of gas, and such a kind of gas as came from the common coal during the ordinary process of distillation, this might not happen; and Mr. Hartley had not given any explanation of the results which the committee had obtained at the South Metropolitan Gas Works, which distinctly pointed to the fact that you might make an error of 2 candles, when you tested 14-candle coal gas by itself with a Methven burner. In reply to Mr. Shoolbred, he might say that a standard had been suggested by M. Becquerel, in which a platinum and palladium couple was heated to a temperature, the intensity of which could be gauged by the amount of current set up; one end of the couple was in a furnace, and the other end was outside, being joined together and kept in melting ice, and a delicate galvonometer was included as part of the metallic circuit. In this case, the two ends being of different metals, and one pair of ends being heated, and the other cooled down, an electric current was set up which would vary in intensity with the temperature. Such a standard, as proposed by M. Becquerel, would at all events be worth trying, although he did not know whether they could get in that way a light white enough to compare with an ordinary gas light. M. Becquerel, himself, in working with this light, had to introduce either red or yellow glass to assimilate the light of the heated metal with the light he was testing. Therefore, he did not think, unless they already knew the ratio between the luminous effect of the yellow light and of the total white light on the eyes, that they could call that an effective standard.

Mr. SHOOLBRED said the introduction of an electric current was felt to be an almost insuperable objection, and, therefore, it was not proposed at the recent Congress in Paris to introduce a current.

Mr. DIXON said Mr. Shoolbred also mentioned that you could assimilate two different coloured lights by means of a polariscope with mica plates, that was, by picking out the spectrum of one light, so as to combine them to make a colour like the colour of the light you were testing. If that were so, he could only say, you could not get the coloured light out of white light without suppressing some portion of it, and that, therefore, such a plan must fail as a photometric method. He must apologise to Mr. Dibdin and to Mr. Sugg for the sperm oil lamp not burning; the fact was, that it had been very dark that afternoon, and he had used the lamp on the lecture table, where it gave a very good light, and he did not know that he had got so near the end of the wick. Mr. Dibdin said the figures were absurdities, and no one working properly with the lamp could arrive at such figures; he could only say, that Mr. Dibdin was there when the experiments were taking place, and the lamp was placed entirely in his hands.

Mr. DIBDIN said he was only there the first evening for a short time, and on that occasion, from causes which might be easily explained, the lamp did not work satisfactorily.

Mr. DIXON said Mr. Sugg's assistant was present the whole time, and Mr. Dibdin part of the time, and he left the lamp entirely in their hands. He certainly thought it was an obstacle to have a long wick of half-an-inch, which had to burn, as Mr. Dibdin said, some time before you got the proper light. Sometimes it took an hour and an hour-and-a-half, and must lead to a certain amount of charring.

Mr. DIBDIN said it ought not to take more than 40 minutes at the outside.

Mr. DIXON said on several occasions it was found necessary to burn it as long as he said, and then the wick became charred. When the lamp burnt properly it gave an extremely steady flame, and was all that could be required for a standard, but the impossibility of adjusting it appeared to them to stand in its way. Of course, if it could be adjusted, it might come into use. He could only speak of the experience they had at the South Metropolitan Gas Works. He ought to add that, by the direction of the committee, he wrote to Mr. Keates after these experiments, pointing out to him exactly what happened, giving him all the numbers that had been obtained, and asking whether he would like any further trial, and as no reply was received, he considered the committee had done all that they were called upon by the Board of Trade to do.

The CHAIRMAN said he felt they owed very much in working out so simple and trustworthy a standard of light as the one that had been examined by the committee with the most scrutinising care, and he could bear testimony to the fact that his colleagues on the committee took the utmost pains in examining that and other standards, that they had no other object than to find the defects and excellencies of each one before them, so as to see which would stand the scrutiny best. The result went to show that, with ordinary care, such as the ordinary worker could be taught to give, Mr. Harcourt's standard did give exceedingly good results, with a regularity and certainty not attainable by any other known standard; but as far as he could judge of what might be useful for rapid daily testings, he saw no sufficient grounds for asserting that Mr. Harcourt's standard should, in practical working, alone be used. He could quite well conceive that it might be practicable to show how some other more simple apparatus might be standardised from time to time by Mr. Harcourt's flame, so as to be, in the hands of ordinary operators, more convenient for common manipulations, but according to the results which were obtained by the exceedingly careful and long continued work of Mr. Dixon, it was undoubtedly true that the standard of Mr. Harcourt afforded at present the most trustworthy means of obtaining, under various conditions, a given quantity of light with certainity. He had no doubt that it would be of considerable value to those to whom it was an object to have with certainty an accurate standard of light, to resort in such a manner as might be convenient to this Harcourt flame, for their guidance in comparing the lights they had to measure. It had been suggested that, under particular conditions, Mr. Methven's burner, under narrow limits to be prescribed, or Mr. Keates's burner, might be used so as to give precisely the amount fixed from time to time by Harcourt's standard, but perhaps it would not be desirable to enter further into this matter at present. He hoped Mr. Dibdin would not imagine that the committee had any desire to judge unfavourably of Mr. Keates' lamp. He was quite sure that they had no other wish, as their conduct showed, than to do justice to everything which came before them. It only now remained for him to discharge the agreeable duty of proposing a vote of thanks to Mr. Dixon for his exceedingly able and interesting discourse.

FOREIGN AND COLONIAL SECTION.

Tuesday, February 28th, 1882; Alderman Sir SYDNEY H. WATERLOW, Bart., M.P., in the chair.

The CHAIRMAN, in introducing the reader of the paper, said it was only during the last few years that the public had felt the necessity for that technical education which had been so general on the Continent. Some years ago, being himself deeply impressed with the importance of this subject, he called attention to it to the long and admirable labours of Mr. Harcourt in the City, when one gentleman, having great influence—a past Lord Mayor—connected with two or three Livery Companies, told him that it was just the thing he did not want. He carried on a particular manufacture, and he did not wish his workmen to be taught so much as to enable them to understand the various methods of preparing colours, and so on. That was a narrow view of the question, and he was glad to say it was not the general way of looking at the subject. The public ought to be very grateful to the Livery Companies for having come forward so generously and unitedly to establish in the City of London a system of technical education. They had agreed to contribute very largely towards the building of an institute, and to allow a yearly sum for a few years to support the schools; but even this generosity had met but a very small portion of the work that had to be done. He felt satisfied that directly the City of London Guilds Institute was at work, the work it would do would show the public that the subject ought to be taken up from a national point of view, as in other countries.

The paper read was on—

SCIENTIFIC AND TECHNICAL EDUCATION IN RUSSIA.

By Professor J. F. Hodgetts,
Of the Imperial College of Practical Science, Moscow.

On returning to England, after an absence of a quarter of a century, I was struck at perceiving a decided decadence in many matters in which I had been accustomed to consider my native land supreme and peerless. The first subject that attracted my attention was the utter ignorance of the English language that pervades all classes of the community; the second was a certain falling-off in the quality and workmanship of various articles of manufacture, while, at the same time, there appeared to be a considerable increase in prices. From my own special point of view, as a public teacher, it seemed natural to connect both these phenomena with one cause, and to seek that cause in some defect in our national system of education. I accordingly applied myself to make some examination of that system, and have learnt in the outset that, properly speaking, we have no system at all.

We are very apt, as true born Britons, ruling the waves, and performing similar grand services for humanity at large, to think "foreigners" a benighted class of men, upon whom the sun of civilisation rarely shines, and then only by reflection from us. We shut our eyes to the many instances where the Germans "have the pull" of us; and it would be regarded by most Englishmen as little short of lunacy should it be modestly suggested that, during the last quarter of a century, the Russians even, had shown themselves no mean rivals, and were advancing still with really gigantic strides.

Is this owing to physiological causes? Does the German race inherently possess higher moral and physical qualities than we do? Is the Russian a higher type of humanity than the Anglo-Saxon? I think we are justified in replying in the negative. In 1851, we were a-head of all civilised Europe. Why are we so lamentably behind now?

From my own experience abroad, the reply would seem to be, that other nations have had education, while we have had none. Other nations have effected a certain amount of organisation, while we seem to stand historically pledged to avoid all system, and to dread the very idea of organisation. In the humble hope of being of some service in this momentous question, I venture to lay before you some facts which have come under my own observation, in reference to the working of the Russian system.

The education of the people is one of the most important problems which the Russian Government has undertaken to solve. From the paternal relations supposed to exist between "Sovereign and Slave," the task has been entered upon in a manner hardly to be comprehended without a more intimate acquaintance with the state of society in Russia than is generally obtained by natives of other countries.

In the first place, the work of the State machine in Russia is, to a great extent, done by the people, who, though not concerned in making their laws, are very actively engaged in carrying them out, for there is hardly a respectable family in the Empire who has not at least one of its members in "the Service." This grand expression, "the Service," includes all officers of the army and navy, and all government *employés* and teachers, who in Russia are as much officers, and are as much in the service of their country, as their military brethren. Social rank vanishes before this omnivorous "Service," and a prince by birth who has contrived to elude it, must yield precedence to the son of a shopkeeper who has become an Actual Counsellor of State.

But to enter any branch of this service it is necessary for the aspirant after distinction to prepare himself for a severe examination by a thorough course of study.

This course of preparation is education or training, and as the schools themselves are Government institutions, the harmony between the initiatory state of pupilage, or, rather, of schoolboy existence, with that of the branch of the service selected by an individual, is such as to lead him naturally on, by regular gradations, from infancy to manhood, in one continuous line.

In the first place, all schools whatever are under the control of the Minister of "Public Enlightenment," who is responsible for the working of the whole educational machine.

Under this minister is the "Aid," or second minister, and some members of the actual Council of State for Educational Affairs; but each educational district throughout the Empire is presided over by a "Popechetil," who has usually the rank of "Actual Privy Councillor," or, in military language, "General." This Popechetil, or guardian, corresponds to the governor of the chief town of the district; and a man of social rank, besides his service grade, is always selected for this duty. This officer is directly responsible to the Minister alone, he has nothing to do with the Council or with the Aid, who do not come between him and the minister. All schools are under his immediate and absolute control. His duty is to visit them, to receive the reports made by their respective directors, to confirm the appointments of all teachers and professors, whose diplomas he signs, when finally appointed to actual crown service. All such professors and teachers must submit to a very severe examination, and the diploma must be signed by the examiners and president of the Board of Examiners, before it goes up to the Popechetil for his signature. No man or woman may teach in any school without having such a diploma, so that the responsibility of the Popechetil is considerable. The inferior officers, such as the ushers, or men who look after the conduct of the boys between lesson or lecture, rank with lieutenants in the army; inferior teachers with captains; professors and gymnasium teachers with majors and lieutenant-colonels; inspectors with colonels, and directors with major-generals. This order of rank pervades the whole empire, and thus organisation is secured, a uniformity of discipline established, and a very perfect system attained.

The schools of the empire are divided into two grand classes—the gymnasial or classic, and the technical, which latter prepares a man for some special walk in life, in which a knowledge of Greek and Latin is not actually necessary. Thus, the so-called Real School (or College of Practical Science), the military and Naval Colleges, the Engineering Schools, and the Technological School *par excellence*, all come under the designation of Technical Schools. The plan of education is similar in all, as far as discipline is concerned; they differ chiefly in that, while the boy who takes the classic course enters the University on leaving the Gymnasium, the technical pupil enters the "Service" as an engineer, a military or naval officer, or becomes a manufacturer or engineer on his own account.

At seven years of age, a boy enters the pro-gymnasium, or preparatory school. Here he remains a year, and is then transferred to the first, or lowest class of the gymnasium, or whatever other school he may elect. In the gymnasium he remains, at a minimum, eight years, there being eight classes, and he is supposed to remain a year in each. Should he be dull, and not pass the examination requisite for his transference from one class to another, he must remain another year in that class; but, if on presenting himself this second year, he be found wanting, he must leave the school altogether; for he cannot be more than two years in one class. Thus, the minimum stay in a gymnasium is eight years, the maximum sixteen. Should a pupil fail, as above indicated, for the second time, in a classical gymnasium, he generally goes over to a Real-school, or *vice versâ*.

On leaving such Gymnasium, or high school, the pupil, on passing the requisite examination, is furnished with a certificate stating the number of years he has studied, and the degree of proficiency he has attained, in the various objects of study. He now passes into the University, and enters the "Service" as student. Here he remains three years, and leaves with the rank of *Candidat*, equivalent to that of lieutenant in the army. He is now eligible for appointment in any Government Office where special technical knowledge is not required. He may become a teacher in a Gymnasium, and rise to be a director, or he may enter the diplomatic service or the Home-office, &c.

The mode of stating the degree of proficiency of any pupil in any school is very simple, and uniform throughout the empire. It consists of a system of marks ranging from one to five. One means low in every thing; 2, passable; 3, good; 4, very good; 5, excellent. In the Military and Naval Gymnasia these marks are the same, and the pupils on leaving school with the proper certificate, enter the army or navy as ensigns or midshipmen. In the Colleges of Practical Science the student, having passed through the 8th class, is eligible for "the Service" as a civil engineer, teacher of natural history, mechanics, mathematics, or any other subject which he may have made his special study.

Besides the above schools, there are commercial schools, where boys are prepared to become merchants, and it is only in these that English is taught, nor is it there obligatory.

In the Gymnasium the chief objects of study are:—Religion as taught by the Orthodox Church, the Russian language, perfectly, and Slavonic, Latin, Greek, mathematics, classic history, modern history, Russian history, geography, natural history, German or French, choral singing, and, when specially desired, drawing.

In the College of Practical Science, the curriculum excludes Latin, Greek, and ancient history, but includes theology of the Greek Church; modern history and political economy, chemistry, physics, mineralogy, mathematics, practical geometry, natural history, drawing, geography, statics, applied mechanics, constructive mechanics, modelling, architecture, mechanical or engineering drawing, French, and German.

In Moscow, there is another school called the Commisaroffskie, where French and German are omitted, and the actual work of practical engineering smiths is taught. The Technological Schools, emphatically so called, have nearly the same curriculum, but instead of omitting the French and German, pupils are allowed the choice of either.

In the Engineering School of Roads and Ways the curriculum is as follows:—Theology, laws regarding roads, political economy, physics, telegraphy, mineralogy and geognosy, mathematics (differential and integral calculus), geometry, drawing, topography, geography, astronomy and geodesy, statics and analytical mechanics, applied mechanics (kinematics, prime-movers, hydraulics and water conduits, aërodynamics) and the steam-engine, constructive mechanics, theory of strength of materials, &c.

In the School of Mines, we have the following programme:—Theology, laws bearing on industrial matters, political and statistical economy, mathematics, geometry, drawing, topography, statistics and analytical mechanics, applied or pràctical mechanics, the art of construction (studies of materials, of works of construction and foundations, theory of the strength of materials, and of the stability of walls and arches, hydraulic constructions, workshops), surveying and levelling, architecture, physics (general and technical), chemistry (general and analytical), botany and zoology, mineralogy and crystallography, geology and geognosy, palæontology, the working of mines, subterranean geometry, assaying, metallurgy, the preparation of designs of mechanical and architectural subjects, and of hydraulic constructions, Russian and Slavonic thoroughly, French or German, or both.

The students of these two engineering schools are not required to remain longer than five years in the establishment; or, what comes to the same thing, there are only five classes, because, generally, the preparatory stages of the first three or four classes of the Gymnasium have been passed through before entering the Engineering School, or the School of Mines. The pupil, on leaving, is absolved from the longer period of military service, having only to pass one year under arms, and he is not compelled to enter the University at all. On passing the final examination, the student of roads and ways receives a diploma, giving him authority for the direction of all kinds of works of construction, with the title of Civil Engineer. This diploma is not signed by the Popechetel, but only by the director and secretary of the institution. The same is the case with the School of Mines, whose students acquire by their diplomas the title and authority of Mining Engineers. The diplomas are signed by the director, the inspector, and two professors. In the College of Practical Science, these diplomas are signed by the director, the inspector, and all the professors under whom the student has studied or has been examined.

In the College of Practical Science great attention is directed to produce and raw materials, and the mode of employing them in the arts and manufactures. There is a museum of such objects, as well as models of the factories which have achieved particular note, and of any special machinery which may have contributed in an eminent degree to such reputation. There are models, of the actual size, of all the parts of working machines and engines. There are laboratories and workshops, and, in the Moscow establishment, where I had the honour to serve, the room devoted to drawing from models is one of the most perfect that can well be imagined.

The payment made by the pupils for all this amount of information is strikingly low. In the Gymnasium the fees are 30 roubles per annum; in the College of Practical Science, 40 roubles; in the School of Ways, &c., 50 roubles; in the School of Mines, 40 roubles. And if a young man be poor, but industrious and intelligent, he is excused from payment of any kind. Fifty roubles = £7 10s.

It is rare to find a Russian who cannot speak some other language beside his own. In general French is spoken a little, even in the middle classes, for the sake of practice. German is absolutely necessary to a people taking their civilisation from Germany, but the Russians always affect to dislike the language and despise the Germans. English is cultivated privately by the aristocracy and the merchants; it is only taught officially in the commercial schools; an attempt was made some years ago to introduce it into the colleges of practical science, but with little success. It is, however, taught in some of the training schools for governesses, which are Crown establishments,

It is impossible to deny to Russia extreme care in the selection of the teachers of the youth of both sexes, and I consider the Russian system in many respects superior to the German, especially in the apparently trivial matter of social rank attached to the office of teacher. Where they fall behind us is in a certain lethargic temperament, probably the result of other influences, and rather a defect in the national character than in the system. Without the system, the Russians would be passive savages, with it they are highly intelligent civilized men.

In England, as far as I know, there is absolutely no systematic technical education; there are no schools in which boys can be educated from the nursery up to the point at which they may be considered fit to commence life as technical men. It appears to me that this want of technical training schools ought to be supplied. Their absence, in a country like England, is quite incomprehensible, and I feel certain that their introduction would do much towards finally establishing our pre-eminence as a nation of scientific workers, which now seems to threaten to desert us.

In Russia, as I have observed, all schools are under the administration of the Minister of Public Enlightenment. Even little private schools of half-a-dozen infants must be licensed, and the master or mistress must have a diploma; while, from time to time, official visits of inspection are made by Government Inspectors, appointed for that purpose, and holding considerable social rank.

In England a license is required before a man can keep a beer-shop, or a gin-palace, or drive a cab; but anybody, however ignorant, may open a school, and, if he please, teach his pupils Choctaw for French, or entirely neglect them, without any let or hindrance whatever, to the serious inconvenience of the respectable British Paterfamilias. This is the let-alone policy carried to a perilous extreme, in a direction of vital national importance.

If I may venture to suggest a remedy for the present anomalous state of affairs in England (for everybody who points out a defect is expected to be ready with a patent nostrum of his own), I would propose the formation of a Board of Examiners, whose duty should be (in deference to John Bull's legal fiction about his house being his castle), not to force compliance with regulations insisted on by a hated bureaucracy, but to invite assistance on the one hand, and security on the other, by granting, at the desire of the masters and mistresses, diplomas conferring certain rights on them, and certificates of proficiency on their pupils.

Good schools would be proud of the distinction, and good pupils would have something tangible to show for their labour; while schools not seeking such distinction, would tacitly confess their inferiority.

It is no part of my plan to enforce Government examinations. It is by individual and voluntary efforts that England has become the great country she is, and it is only by individual and voluntary efforts that England can maintain her position. Therefore, while advocating the foundation of a Board of Examiners, to be appointed by the Government, I would not make official examinations obligatory on private schools; nor would such a step be necessary, as parents would naturally prefer placing their children at schools which did not shrink from official examination.

I would make the advent of the examiner rather a favour shown than a hardship to be endured and dreaded; a favour for which a fee—perhaps almost nominal, but still payment—should be demanded, in return for the advantages and distinction conferred on the school by the Board, and for those incident on the possession, by a successful pupil, of a Government certificate.

Whether the Board should be a travelling body, a permanent Commission sitting in

London, or an organised council having its branches in all the principal towns of the United Kingdom, I shall leave to the consideration of more political and more financial minds than my own.

DISCUSSION.

Mr. Owen Roberts said he rose in response to the Chairman's invitation, but he was hardly prepared to say much on the subject of the paper. He certainly was very much surprised to learn that we had to go to Russia to find out what to do in the matter of education. He should be very sorry to see education organised to death, and he thought that to follow on the model of what had been set forth in the paper, would strangle freedom in educational matters. He did not attach any importance to the fact of teachers being made major-generals, colonels, captains, or anything of that sort. Teachers in this country did not occupy the same position twenty-five or thirty years ago which they did now, but he would rather see them attain a high social standing by virtue of the confidence placed in them by their fellow-countrymen, than that it should be given them by the Government. With some of the remarks of the reader of the paper they must all agree, especially with regard to the certification of teachers. Sir John Lubbock had a measure in hand for the purpose of dealing with this point, and he was only surprised that session after session passed by without any result being come to. It was scandalous that middle-class schools should be opened in England, without any certificates of competency being required on the part of the teachers; and they would all agree with the author in his remarks on that point. In the list of subjects studied in the technical schools in Russia, he noticed that the first thing was theology, and he certainly hoped that example would never be followed in England. As to languages, it was stated by Professor Hodgetts that it was rare to find a Russian who could not speak some other language beside his own. He supposed the Slavonic language was the native language of South-eastern Russia, but he should like to be corrected if he were wrong.

Professor Hodgetts said that the Slavonic, or that which was called the Slavonic, was, properly speaking, the old Bulgarian, or church language, and it had to be learnt by all persons who went to church, and as everybody must go to church, this included the whole population. It was never spoken anywhere, and it was only learnt for the purpose of understanding the priests, and reading the ancient literature, and it required an immense amount of Slavonic to do that. But it was a decided advantage for the Russians, which we do not possess, that the mother tongue was generally well taught in all schools; and it would be a good thing indeed if English were as carefully taught here as Russian in Russia. As it is, English is studied by very few Englishmen. He thought probably the time occupied in this branch of study, as far as technological schools were concerned, might be more beneficially applied to other subjects. The priests were, generally speaking, ignorant persons, who got their living by teaching theology in these schools, and this could never be done away with whilst the Church was at the head of affairs, as it was in Russia. He had only stated what was the state of things existing there, and although he did not approve of all, he nevertheless thought there were some things worthy of serious consideration.

Mr. Owen Roberts continuing, said they must all agree that technical education in England was lamentably defective. There was very little of it, and what there was required a great deal more organisation than at present existed. He understood that the art teaching of the Government was going to approximate moreclosely to technical art instruction, and he was also glad to hear that in the coming estimates there would be a more liberal provision for the teachers who applied themselves to the education of those persons who were engaged in industries, and who had the strength of body and mind to devote their evenings to self-improvement. It was impossible to engage in technical education to advantage, unless the students had received a preliminary education to prepare them for it. He had heard, too, that the science schools of the country were going to sustain a reform at the hands of the present authorities in a direction much to be desired, and he hoped it would make the work of the teachers easier than it had been. He believed that the foundations of the scheme laid by the City Guilds were essentially sound. He thought the scheme deserved very considerable praise, and he felt sanguine as to the results which might be obtained from developing it. He did not profess to be specially acquainted with the fact, but he understood that the civil engineers in England were about the best in Europe, although they were not educated by the Government, as the Russian engineers were. He hoped to see the time when every boy and girl would be taught the reason "why" for everything; when the phenomena of life around them would be explained to them, and they would be taught to catechise nature. When they had than groundwork to start with, he hoped that every town would have a technical school. He hoped that boys would always be sent to work moderately early, as they would be much better able to acquire deftness of touch and manipulation than if it were put off till later. By means of half-time schools, and schools affiliated to large workshops, such as Messrs. Platt's, at Oldham, workmen could be taught the sciences which underlay their everyday life, side by side with the training in their handicraft. Formerly, the master had only two or three apprentices, and then he could explain the work thorougly to them; but under the present system, when capital had assumed such a feature in industry, it was impossible for the master—who might have 100 or more apprentices—to teach them in the old-fashioned way. He hoped schools would be formed where professors of industry—persons not only having a knowledge of the craft, but a knowledge of the science connected with it—would be able to explain to the apprentices the *rationale* of the operations in which they are engaged. If we had technical schools throughout the country, based on these principles, we should go far towards grappling with the difficulties arising from the decadence of the apprenticeship system.

Mr. G. CHRISTIAN MAST said that one of the main points urged by Professor Hodgetts, was that schools and teachers should be registered. That was not a new idea, as the teachers had urged it upon the public repeatedly, and it was in the hands of the College of Preceptors, who had drawn up a scheme, and placed it in the hands of Sir John Lubbock; but owing to the Irish question, and other causes, it had been postponed. He hoped the registration of teachers would be carried out in this country, in order to exclude persons who were unfit, as was the case with doctors. At the same time he did not think we ought to go to Russia for a pattern as to educational matters. Many of the schools in Russia were without teachers, and there were far more children in Russia who had no education whatever, than in this country. The reader of the paper had been away a long time, and he was not, apparently, aware what a great deal of technical education was going on in the private middle-class schools. He hoped that the principle of liberty would not be abandoned. England had done very well with freedom of teaching, and if it was properly organised and extended, good results would be obtained.

Mr. E. C. ROBINS was astonished to hear the lecturer say that he found us worse off in these matters than we were twenty-five years ago. For his part, he must say that he had seen an enormous growth since 1851; which period was the starting point of education in this country to an extent that few people considered. Since that time, a system of education in primary schools had been commenced, and he could not understand the statement that we had gone back in English, as that had been taught in these schools for the last ten years. With regard to the system adopted in Russia, it was exceedingly like that which prevailed in Germany. Germany stood at the head of every country in Europe in this matter. He had found, when on a visit to that country, that the teaching in the science classes was very thorough and very perfect, but it partook more of the collegiate kind of education than it did of the workshop. At Chemnitz they preferred the pupils from the ordinary schools to those from the university, as the latter were too highly educated. There they have what are termed technological professors, as well as general professors of each science. The latter teaches the pure science, and the former the practical part of that science. There had been, during the last five years, an enormous increase in the buildings for technical education in Germany. At Strasburg, an enormous university was being built, and there was one building in connection with it for physics, which would cost nearly £40,000; another for chemistry, £40,000; and another for botany and forestry, £40,000; whilst the main building, for general education, would cost about £100,000. There was scarcely a single town where some building had not been erected for technical education. The results of all this learning in Germany were not such as might have been expected, especially as regards art. There was a great deal of copying from English works, even as regards the designs for calico printing. The architecture had great sameness, and the independent style of art which characterised this country was not known there. There was a great amount of originality on the part of our people, which enabled them to be successful, notwithstanding the absence of many advantages, but with those advantages, there was no reason why they should not eclipse the world.

Mr. EDWARD HAWTREY thought there was a strong feeling in the public schools in favour of more time being given to technical education. They would like to see some man with the power of organising, of a Temple, or of an Arnold, who would boldly shake himself free from the trammels of old traditions, and would give freedom for boys, after the age of 14, to take up as an entire subject either music or mechanics, or any analagous studies. He thought there would be no real good done in the public schools in the way of technical education until they found a head master who would boldly go in for that line, and rest the reputation of his school upon it.

Dr. YEATS wished to point out that this was not the first time the Socicty had dealt with this subject. Some time since a very valuable article had appeared in the *Journal*, (vol. xxvii., p. 96) giving an account of the Massachusetts Institute of Technology, and the special feature to which attention was drawn was this, that at the Centenary Exhibition at Philadelphia, Russia had for the first time succeeded in what he might call the analysis of a number of handicrafts. Each stage of progress in each handicraft had been carefully considered. A series of these processes had been laid together, and out of them a system formed which he might term a grammar of industry. Specimens of these handicrafts in wood and iron were placed before visitors to the Exhibition and they had so much effect on the American mind, that they were alluded to in almost every report, and they are said to have laid aside some of their Whitney schools, and substituted schools in which the Russian manual element was introduced. His own attention was first drawn to the matter at the Great French Exhibition, when he saw a great deal that had come to Paris from Philadelphia.

Mr. H. SOLLY would like to hear more about the manual part of technical education. It had been pointed out that the apprenticeship system had broken down, and they wanted to know what was to take its place. No amount of ordinary teaching in science and art classes would give what was required, and this might be observed on the authority of the workmen themselves, who said that if they merely learnt the principles of science and art in class-rooms, they were unable to apply them in the workshop. They must be taught to apply the principles in technical laboratories, and nothing would take the place of this missing link.

Professor HODGETTS, iu reply, said with regard to some of the observations made on the paper he had had the pleasure of reading, that he had been a little misunderstood as wishing to praise the present state of Russia *quoad* education in comparison with England. His disappointment on returning to England was probably due to his expecting too much. He was an Englishman, heart and soul, and he had never ceased to feel the superiority of his country in almost everything. When he came back expecting so much, he found this country behind other countries in technical education, and in other points to which he had drawn attention in this paper. He had not the slightest wish to see military discipline enforced on Britons; he had merely stated what was done in Russia, in the belief that part of the system might be applicable to our wants. He had seen a great deal of the German system of education, and had observed that there was a preponderance of theorising over practice. With reference to the question of teaching theology in technical schools, the Russians must be religion to consist in a series of forms which consider observed and gone through as a sort of military discipline by every man, and to know these forms is a necessary branch of education, *ergo* in every school you have the forms and ceremonies of the church taught. In Russia there was not full freedom of thought. If a man did not believe in the orthodox church he could not do anything; if he were the cleverest engineer possible, and he had spoken against the church or did not believe in it, he would be done for. The technological schools have been in existence about twenty years; and the Commisaroffskie school was founded by the late Emperor in 1864. Everything which can be called civilisation has been drawn from the Germans, and it will easily be understood that the system of education should be more German than anything else, but with a professed disinclination to be followers of the Germans, they have endeavoured to strike out something, and all they have succeeded in accomplishing is a more involved system. How that system works is shown by the fact, that English and German workmen as overseers in factories are always preferred to Russian, notwithstanding the superior theoretical knowledge possessed by the Russian. With regard to the question of apprenticeship, it was extremely unsettled in Russia. There was on fixed term; if a man wanted to become an engineer, he had to go to one of the large schools, and after he had obtained his diploma, he would go to a factory or mill, sometimes only for two years, sometimes for five, or even seven, and then he would receive a certificate of having acquired a sufficient knowledge of his art to entitle him to obtain the position of master or superintendent. Such private certificates could not always be relied upon, for they open a door to personal influences, which it is somedangerous to do, as a rich man, by paying the master, could get a certificate for his son, whether he was competent or not. It was a mistake to suppose that those technological schools would supply the place of skill. With regard to the grammar of industry, the Russian has considerable proficiency so far as theory is concerned; but he had never seen anything yet produced that was a satisfactory production of all that is desired.

The CHAIRMAN said they had listened to a very interesting account of the way in which technical education had been developed in Russia, and they should learn what to accept, and what to avoid. The Professor had pointed out that in all these schools, amongst the subjects taught, theology was at the head, but it might be questioned what good results could be anticipated from this. He did not think technical education, as they were now endeavouring to establish it, could be regarded as taking the place of apprenticeship, but rather as supplementing it, and enabling the apprentice to understand the why and wherefore of the work upon which he was engaged. The apprenticeship system had undergone a great change, in consequence of the methods of manufacture being so different to what they were formerly. Now-a-days, a workman was frequently engaged entirely in making one particular part of a machine without even knowing its relative position, and that rendered it necessary to have technical schools to teach the workman the relation his piece of work bore to the beautiful piece of mechanism of which it was a part.

A vote of thanks was accorded to the lecturer for his interesting paper.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 1st, 1882; Sir JOHN LUBBOCK, Bart., M.P., F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Crabtree, Henry, 26, Stangate, Westminster-bridge-road, S.W.
Fletcher, Thomas, F.C.S., Museum-street, Warrington.

Moritz, Edward, Ph.D., F.C.S., 72, Chancery-lane, W.C.
Neison, Cuthbert G., Ph.D., 173, Fenchurch-street, E.C., and East London Chemical Works, Mile-end, E.
Preston, William Howel, 8, Victoria-street, Westminster, S.W.
Robinson, J., Bryn-y-Mor-house, Llanfairfechan, North Wales.
Robinson, John, M.I.C.E., Westwood-hall, Leek.
Steuart, David Vincent, Albert Chemical Works, Clayton, Manchester.
Webb, Charles S., 16, Coleman-street, E.C.
Webster, Ernest William, The Firs, Waltham Abbey.

The following Candidates were balloted for and duly elected Members of the Society:—

Akester, William Hopkin, 111, Great Western-road, Glasgow.
Bayley, Edmond Kelly, 2, Lancaster-street, Hyde-park, W., and 11, King's Bench-walk, E.C.
Canning, Thomas, The Retreat, Clytha-park, Newport, Monmouthshire.
Cochran, William, Overdale, Dunblane, Perthshire.
Coote, Capt. Frederick, 34, Newington-green, Stoke Newington, N.
Denniss, William John, 344, Wandsworth-road, S.W
Heisch, Charles, F.C.S., F.I.C., Holly-lodge, South Park Hill-road, Croydon.
Howard, John, F.C.S., Islington School of Science and Art, Windsor-street, Essex-road, N.
Hummel, John James, The Yorkshire College, Leeds.
Malan, Ernest de M., District Railway Works, West Brompton, S.W.
Scott, James, Universal Electric Company, Limited, Baltic Works, Bridgeton, Glasgow.
Varley, Frederick Henry, Mildmay-park Works, Highbury, N.
Wrigley, Percy T., B.A., 23, Sydney-street, South Kensington, S.W.

The paper read was—

THE TEACHING OF FORESTRY.

By Colonel G. F. Pearson.

Part I.

In presenting myself before you this evening, I would solicit your indulgence in my endeavour to offer to your notice a few facts about forestry, a science which is daily attracting more and more attention in all the countries of Europe, as well as in the colonies of Great Britain, and in the United States of America. This is, no doubt, owing in part to the depressed condition of agriculture during the last few years in Europe; but it is due also largely to the increased demand for timber which the advance of civilisation brings with it. For where in some industries, as in ship-building, iron has largely taken the place of wood, in numberless others, as in railway works, the drain on the forests has enormously increased. I trust, that, without entering into any complex questions of sylviculture, which, however interesting in themselves, would be too long to discuss here, I may be able to place before you a few facts which may be worthy of your attention. I will first endeavour to give you a short sketch of the rise and progress of scientific forestry in European countries, and afterwards very briefly to explain the principles on which it is based.

Sylviculture, or the culture of forests, as it is understood and applied in the countries of Europe, where it has been studied as a science, is the application to woodland property of certain economical principles, which, in their spirit, contain nothing more than what is held to be necessary for the well-ordered management of landed property in general; and which may be summed up as follows:—

1st. The obtaining, within approximate limits, of a regular sustained revenue from the land which the forest covers.

2nd. The utilisation, to the fullest extent possible, of the natural productive powers of the soil.

3rd. Progressive improvement in the value of the property.

4th. Final realisation of the crop to the greatest advantage.

It is in the development of these principles, and in their application to forests of different sorts, that the true science of forestry consists.

Now, for various reasons, but chiefly on account of the abundance of coal in Great Britain, and the facilities of obtaining at cheap rates all sorts of timber from other countries, which our commerce affords, the management of forests has not as yet attracted so much attention among ourselves as it has done elsewhere; and even where, as in Scotland, considerable natural forests existed in times past, since railways have penetrated into distant parts of the country, they have too often been cut down, and their value realised; and in consequence, natural mature forests of any great extent do not at present exist in Great Britain; and though there are a fair amount of plantations, in various stages of growth, and some of them of considerable extent, and in excellent order, their treatment has up to the present time been confined to simple cultural operations, and their management as forest property has been but little thought of. To this may be added the fact, that all the great forest properties in Scotland, and most of those in England, belong to private owners, whose interests will not always allow of their working their forests, for results which can only be properly developed after a long series of years. These and other similar reasons have, up to the present date, stood in the way of the growth among us of any sound system of managing our forests ; but there can be no doubt that the subject is now beginning to attract a far larger amount of attention than it has ever yet done before.

Before going any further, it may be interesting to sketch briefly the history of the rise and progress of forest science on the Continent of Europe.

During the early periods of civilisation which succeeded the Roman occupation of Gaul and Great Britain, the forests, both in our own country and on the Continent, covered vast areas of country, and it was one long continued struggle of the population against their growth, which was then equally an enemy to pasturage and cultivation ; often, too, where border feuds and wars were of constant occurrence—as in Scotland between the different clans, and also between the lowlands and the border counties of England—the forests were burned and destroyed by the conquerors, in order that they might not be used as a refuge by the other party, or as a shelter for making reprisals. The timber, as such, had then no value whatever. Later on, while the population was still sparse, and roads and other means of communication were few and difficult, timber had but little value, except near the large towns, and at this time the forests were objects of interest only to the princes and nobles, who used them as their hunting grounds, and who carefully preserved them from encroachment as long as their interests in this particular were not interfered with—but not otherwise, for it was at this period that those common rights sprang into existence, which, arising out of compromises between the population and the nobility, have in later times proved such a fertile source of trouble to forest conservators both in England and on the Continent.

It was about the beginning of the seventeenth century that the then rapid disappearance of the forests seems to have first attracted attention in the different countries of Europe ; and among the first traces of attempts at forest management, certain regulations may be quoted, which were made so far back as the reign of Elizabeth, to regulate the number of standard trees in the oak-coppiced forests belonging to the Crown. In France, the *ordonnance* of 1669, issued at the instance of the great minister Colbert, had a similar object. These regulations, however, were simple measures of police, restricting the felling of certain trees, under certain conditions, and they contained no scientific principle whatever ; while the agents employed to carry them into execution were probably persons of the lowest class, living in the immediate neighbourhood of the forest, and consequently too often ignorant, dishonest, and interested, as the long list of fines and punishments inflicted on them for frauds and embezzlements, which still exist, seem to indicate. It is very doubtful if the forests even benefited at all from their care. Nevertheless, the subject was not entirely lost sight of in France, as the studies of Duhamel de Monceau, Linné, Bernard de Jussieu, Buffon, and Cuvier go to prove. Later on, attempts were made to work on what we should call, now, a regular system ; by fixing a certain period called a revolution, in which the forest was destined to be cleared off entirely, and reproduced by natural seeding; and to this end it was divided into a number of compartments equal to the number of years in the revolution, one of which was felled every year, or at such regular intervals of time as was determined in the working plan, a few standard trees only being left as seed-bearers. This system was known in France as that of *tire et aire*, and continued in operation till within the last half century. But this, as is now well known, will not suffice to ensure the regular natural reproduction of a forest, and, in consequence, it often happened that those so operated on were either ruined entirely, or were changed altogether in their character. Indeed, any approach to sound forestry was unknown in France till the forest school was established at Nancy, in 1824.

Previous, however, to this date, and, indeed, before the close of the last century, considerable progress had been made in the right direction by the German foresters on the other side of the Rhine, who were undoubtedly the first to base the principles of forestry on observation, and to treat it in a scientific manner—Hartig (1762-1837), Cotta (1763-1844), Hundeshagen (1783-1844), were the founders of that system of working forests by thinning at regular intervals, first, for the improvement of the crop, and afterwards for its realisation, which has since been developed into a regular science in the forest schools of Germany and France. Hartig founded the school of Dillenberg, in Nassau, where, in the year 1800, he had at least 70 pupils. Cotta founded that of Thorandt, in Saxony, which in the year 1812, numbered upwards of 100. These schools seem to have disappeared about the year 1820, and were replaced by others in all the German States, viz., at Elberswalde, in Prussia (founded in 1867), Tharand, in Saxony (founded on the old establishment of Cotta, soon after 1820); Münden, in Hanover; Giessen, in Hesse; Aschaffenburg, in Bavaria; Tubingen, in Wurtemberg; Eisenach, in Coburg. It was not till the year 1824 that any step was taken in the same direction in France, when the Nancy school was founded, with Lorenz as its first director. The *Code Forestier* was published in France in 1827, but it was not till 1837 that the first edition of a work on forestry appeared there, in the shape of the lectures of Lorenz, edited and published by his successor, Parade, at the Nancy school. Since then, however, the works in France has been vigorously developed, and the Nancy school has taken a high place among the schools of Europe, chiefly owing to the long and happily uninterrupted labours there of Monsieur Nanquette, the late director, the late Professor Bagneris, who for 22 years was Professor of Forestry at the school, and Professor Broillard, now Conservator of Forests at Macon, whose teaching, and whose work on forest management, have done more, perhaps, than anything else to clear the subject of forestry in France from empiricism, and to place it on a thoroughly practical foundation. Nor have the Germans, who first led the way, remained behind their French colleagues, as any one who will take the trouble to visit their admirably managed forests must allow. Nowhere can the practical results of the natural system be seen better than in some of the German forests, where it has been in operation in some places for at least a century.

Besides the establishments for teaching forest management in Germany and France, schools of sylviculture now exist in all the principal countries of Europe, except in Great Britain. Austria, Italy, Russia, Switzerland, and even Roumania, most of them, after sending pupils for a few years to the French and German schools, have set up schools of their own, and thus rendered themselves independent of foreign educational aid. The United States of America, only last year, sent an able and distinguished man (Dr. Hough) to visit all the forest schools in Europe, with a view of founding one in America; and it is no doubt to be regretted that, as yet, no steps have been taken to do the same in Great Britain; for with us, as elsewhere, a forest school would become, not only an establishment for teaching sylviculture, but also a centre of study and practical observation, from whence a knowledge of sylviculture, as a science, would be spread abroad, for the benefit of society in general.

It is certain that unless the forests of a country are properly and economically managed, the time may come, when as was the case in India, it will find itself without the means of procuring the needful supply of timber, except at an extravagant price; while at the same time the general interests of the community require that a fairly abundant and cheap supply should be constantly available This is especially the case where, as in the great continental areas, deficiency in the means of transport, or the distance from the timber-producing tracts, adds materially to its cost. In such cases experience has shown that the only practicable way out of the difficulty is for the State to intervene; and although in England we have special facilities for supplying our wants from abroad, owing to our extended commerce with all countries, the extreme limits of a reasonably cheap supply seem to have been reached; and at all events State action seems so far desirable as to help private proprietors to make the best use of their timber-producing lands.

In India considerable progress has already been made in the right direction; for there the question forced itself into notice more than a quarter of a century ago, and the first steps for forming a regular forest administration there were taken immediately after the mutiny. Dr. Brandis was appointed Inspector-General of Forests in 1863, and in 1867, his scheme for training foresters for India in the schools of France and Germany was, after much discussion, adopted finally by both the Home and Indian Governments. Indeed, as a matter of fact, at home there were neither foresters who could teach the science of sylviculture, nor schools in which it could be taught. It is not too much to say that, in spite of the drawbacks inherent in such a system, the result has amply justified Dr. Brandis's expectations, for the foreign schools have given the State a body of able men, thoroughly grounded in the management of natural forests covering extensive tracts of country, as they do in

India. But meanwhile, nothing has been effected for the advancement of forest science at home; and this is, in consequence, the weak point in an otherwise admirable system. The practical disadvantage of this is now beginning to make itself felt in regard to our Colonies, where forest management is now manifesting itself as the great economic question of the day. Within the last two years both the Cape of Good Hope and Cyprus have been furnished with forest officers from France, owing to the absence of any available educated men in our own country. The Mauritius, Ceylon, the Straits Settlement, Hongkong, Fiji, and other Colonies, are all following suit, and have recourse to Kew and other similar institutions for foresters. But these institutions are incapable of supplying their wants, for the creation of plantations is a very different study from the management of forests which already exist in a natural state.

Now, the cause of the present difficulty is not far to seek. It is that there lacks with us anything like a central establishment at the head quarters of the Empire, from which experts might be sent to the Colonies, and from which our own great proprietors of woodlands would, doubtless, often too gladly supply their wants for foresters. We have now, in India, a fair number of educated foresters, who know their work well, and some of whom, at least, are men of high professional attainments, able to hold their own with the highly educated foresters of the Continent. It is not too much to hope that the services of some of these men might be utilised, to teach forestry at home, and to put in order some portions of forest in England and Scotland, where practical instruction in the what is known as the natural system of sylviculture, might be given. Thus, in due course, England might become independent of foreign countries for the education of her foresters.

PART II.

It will be now right that I should, with your permission, explain as briefly as possible what are the principles of forest management as taught in these schools.

Forestry divides itself into two branches; the first is called sylviculture, or the culture of woodlands in all that concerns the crop which grows upon them; the second refers to their administration from an economic point of view, or, in regard to the supply of timber for sale or use by the community, and the revenue to be derived from them.

As regards the first, it may be said that there is no mystery in scientific forestry. It means simply to observe the action of nature in a forest, and to follow it, or to utilise it for our advantage, when we are able to do so. Its object, then, should be to obtain the utmost possible advantage from the soil, by keeping it always covered by a growing crop of trees; and, when the trees arrive at maturity, to remove them in such a manner that the smallest possible interruption may be caused to the productive work of nature in the forest.

Now, the natural reproduction of the forest, when the trees are removed, is the corollary of the above considerations. In a natural state, the reproduction of the forest is effected by the germination of the seed which falls from the trees in it, whenever the necessary air, light, and warmth are admitted to the ground, by the fall of any tree, either from accident or age; the work being carried out gradually, and the soil never being exposed over any large area at once. For the young seedlings which spring up would wither and perish at once, unless they were sufficiently shaded. So in forest operations, when the time has come for the removal of the timber, on no account should the ground be anywhere cleared of trees at once; but a commencement should be made by felling a tree here and there, and so breaking the thick cover of the forest, to allow sufficient air and light to reach the ground, and so cause the seed which has fallen to germinate. In this way, about one-fifth of the mature trees should be removed every 5 or 6 years, never breaking the cover by making large gaps in it, but taking a tree here and there, and always leaving the finest and most vigorous trees till the last; so that in about thirty years the whole of the old trees will be cleared off, and a new forest established in their place. Thus the seeding of the forest will be effected by the agency of the finest trees, which will be themselves all the while increasing in bulk, and thus the productive power of the soil will be utilised to the fullest possible amount. A short calculation will show that a tree 10 feet in girth, which makes a ring of wood of only one-eighth of an inch in thickness, adds to its bulk at the rate of rather more than one cubic foot of timber annually for every 10 feet of the length of its stem; or, in other words, such a tree, if its stem be 30 feet in height, will, in 30 years, have increased in bulk by at least 100 cubic feet of solid timber. At the same time, during these 30 years, the young trees which are springing up will become perfectly hardy, and capable of supporting the whole force of the summer heat and winter frost. Nothing, then, is lost by the system of natural reproduction, as must be the case when a forest is cut down to be re-planted; for not only in the latter case is there a degradation of soil from exposure, but also a dead loss in the production of woody material during the whole time that both the old crop and the young can remain on the ground together with mutual advantage.

But it is not only in the removal of the timber and the reproduction of the forest, that we ought to study the action of nature. It is equally necessary that we should do so in the felling for improving the growing crop, or as they are commonly called, thinnings. To understand this, let us glance at the constitution of a high timber forest, in its natural state, that is to say, a forest, whatever be its age, springing from seed, and therefore, capable of living and thriving through a long series of years. In such a forest the trees will, when young, form an almost impenetrable thicket of various heights; later on, they begin to assume a definite form, and being in close contact with each other, they soon begin gradually to lose their lower branches, which fall off and wither; but as a compensation, they throw all the vigour of their growth into their heads; and as these push themselves upwards, seeking the light of the sun, the stronger ones overtake the weaker, so that a certain number of the latter perish and disappear each year. When about half their full age, the trees will have attained their full height; but from that time till they arrive at maturity they go on always augmenting the diameter of their stems, but at the same time decreasing in number; so we may calculate that, if 1,600 trees of four inches in diameter can stand and thrive on an acre of ground, there will not be above 400 when the trees are eight inches, 200 when they have attained twelve inches, and from 100 to 140 when they are sixteen inches in diameter. In our thinning operations, then, these considerations should be our guide. In the early stages of a forest's growth, there is little to be done except to keep the heads of the young trees of the most valuable species from being overtopped by those which stand near them; and this can be best done, not by removing the others, but by cutting off or breaking their tops; for it is in this stage that the process of natural pruning is going on, which nature does so much better herself than we can do it for her, and to this end it is necessary that the trees should grow as close as possible together. Later on, when the trees have taken a more regular form, we can assist nature, and, at the same time, save much valuable produce by judicious thinnings, which should be arranged so as to pass through the whole forest at intervals of from ten to fifteen years, so that the whole area may be operated on in turn. In executing these, the most delicate of all forest operations, it will be well to remember that their object is to give room to the heads of the trees, and not to their stems; for the stems will never be too close together, as long as the heads have room properly to develop themselves. The details, however, which govern the operation of thinning differ for almost every species of tree operated on, and to touch on them would be to enter upon a whole course of lectures on forestry. It will be enough to say here that, in every case, the favouring of the most promising trees, and the removal of the weaker ones, together with the preservation of continuous shade to the surface of the ground, while all the trees have sufficient room to grow, should be the object aimed at.

The second point to be considered is the administration of forests from an economic point of view, or with reference to the revenue to be derived from them.

Now, the basis on which all sound forest management depends, is the revenue which any forest can be made to pay—that is to say, the income which it will produce in proportion to the volume of the standing trees; or, in other words, its capitalised value. This principle has been accepted as the base of the science, equally in the French as in the German schools, which, differing considerably, as they do, in the details of forest treatment, both start from this same point. To this end a forest should be considered as so much capital, represented by so many cubic feet of wood; while the amount of wood produced each year, by its growth, represents the interest thereon, and, in fact, is the revenue of the forest. It is evident that it is possible to cut and remove every year a quantity of timber equal to this annual increase of wood, without diminishing the volume of the standing crop. The quantity that can be so removed is the proper yield of the forest—that is to say, the continuous yield; and French foresters have called it "the possibility"—or possible annual yield—of the forest.

Now, if we suppose that a period of 150 years will be required for the youngest trees in a forest to arrive at maturity, it is evident that the 150th portion of it might be felled every year, and that the increase of timber in the rest of the forest would equal the volume taken away. But, as we cannot apply such a plan in practice, and at the same time insure the reproduction of a high timber forest, we arrive at the possible annual yield in another way.

1st. In order that we may have to deal only with areas of a workable size, the forest is divided, in the first place, into large blocks, or divisions, which should not be more than 2,500 or 3,000 acres each, and arranged generally so as to be convenient for the roads, rivers, or other means of transport for the timber. Each of these must be considered, and dealt with as a separate forest by itself; and to each a period is assigned, in which the whole of the present crop of trees will be removed, and the youngest now on the ground will have come to maturity. This will be about 200 years for oaks, 120 to 150 for beeches and Scotch firs, and so on. These divisions are again subdivided into (usually) four or five working subdivisions, or compartments, to each of which a sub-period of thirty years or thereabouts is assigned, as being sufficient for the removal of all the old trees in it, and the reproduction of the new crop. There must be, then, as many sub-periods in the number of years assigned for the complete working out of the forest as there are sub-divisions in the whole forest. We take whichever of these sub-divisions contains the geatest number ot mature trees, and assign to it the first sub-period of 30 years, calling it No. 1. We count and measure the trees in it (neglecting all, if there be any, of less than four inches in diameter), and ascertain the total volume of timber they contain. This, divided by 30, or whatever is the number, the number of years in the sub-period will give, as is evident, an amount or volume of timber somewhat short of the possible annual yield, but near enough to it for all practical purposes; it remains then, only to remove, each year, from this compartment the quota of timber indicated above, following, in doing so, the method for the reproduction of forests explained just above—that is, we should remove one-fifth of the trees from one-sixth of the surface of the sub-division each year, or thereabouts; taking care not to exceed the volume indicated as the possible annual crop.[*]

The other sub-divisions or counterparts will be numbered 2. 3, 4, &c., and to each of them a sub-period will be assigned in succession. In the meanwhile, the necessary thinnings and the removal of trees that would otherwise perish, must be carried on continually during the first sub-period in all the other sub-divisions, so as to go over the whole ground at regular intervals, not exceeding 15 years each. At the conclusion of the first period, No. 1 will contain a young crop of trees, from 1 to 30 years old; and then No. 2 will be taken in hand; and after No. 2, then No. 3, and so on until, in the full period, the whole forest will have been renewed without the ground having been once entirely cleared of trees. Anyone visiting Baden Baden will do well to explore the forests in the beautiful valleys of the Oos and the Murg, in its immediate neighbourhood, which furnish a splendid example of the successful working of forests on this system. These forests are easy of access, being on the high road to Switzerland, and I mention them on that account, As examples of private forests, which have been admirably managed in the same way, I may mention those of Prince Furstenburg, near Rippoldsau, to the east of Baden Baden, where there are some excellently constructed and most ingenious devices for bringing timber down the mountain torrents to points from which it may be carted away.

But, besides forests which spring from seed, there are others which consist of shoots springing from the stools or stumps of trees which have been felled, and which are commonly called coppiced forests. In many cases these give very good returns for hop-poles, mine-stays, bark, and other purposes for which large timber is not wanted. Their management is well understood, and the only points on which suggestions may be offered, are:—

1st. The necessity of giving sufficiently long intervals between each felling, as every time the copse is cut, the soil suffers from exposure, and its fertilising power is wasted, as it is also by the production, during the first four or five years after the cutting, of a mass of useless grass and leaves, which profit nothing.

2nd. The necessity of using sharp instruments for felling, and cutting the wood close to the ground, leaving the stools or stumps of such a form, that the wet may run off them. These precautions are necessary for ensuring healthy re-shoots.

3rd. The cutting of the copse, if possible, in the early spring instead of in the winter, as is usually the case. If the work is done just before the sap begins to move, the shoots are made at once, before wet and rot have attacked the stools, and rendered the production of healthy, vigorous shoots impossible.

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[*] Trees cannot be made to grow spontaneously in a forest, as we can place the men on the squares of a chess-board. The distribution of the fellings, must therefore, really depend on numerous cultural exigences which develop themselves from time to time, which time will n6t admit your noticinng here.

It may be added that the more standard trees that are reserved in a coppiced forest, the greater will be its value; and there is nothing to prevent their flourishing over the lower growth, which serves to keep up their heads, and to give them a clean stem.

Now, what is the practical application of all this? We have in Scotland about 800,000 acres of forest which have been planted during the last hundred years, for few of them exceed that age. Besides these, there are a small remnant of the old natural forests in Strathspey. In England we have, belonging to the Crown, about 50,000 acres of forest, the greater portion of which has been planted within the last hundred years also, with some remnants of the old natural forest, chiefly in the New Forest. It is impossible to speak too highly of the admirable work done by the able men who have created these forests at Scone, Blair Athole, Dunkeld, in Strathspey, on the Findhorn, and at Beuly, in Scotland, as well as in some of the English Crown Forests. In our Colonies, including India, there are millions and millions of acres of forest land, some of which is of the greatest value, so that Great Britain is, perhaps, the country most richly endowed in forest wealth, of all the countries of the earth. Every one, not only in our own country, but elsewhere, is interested that all this great forest-wealth should not be wasted or frittered away by a single generation of men. But, nevertheless, what is the future of all the forests? I have visited many of them, and scarcely anywhere did I see any of that youug growth which are the links uniting the forest now on the ground with that of the future. Can any one say, then, that the future of these forests is assured? As at present they exist, one of two conditions must befall them. Either they will be cut down and the timber sold; or they will in due course perish naturally, and disappear of themselves. In either case the result is deeply to be deplored, for when once a forest disappears, it can only be replaced at a great expense of time and money.

It is for this reason that I am here to advocate the establishment—be it on the smallest scale even, to commence with—of some system of national instruction in scientific forestry. Hitherto, we have been entirely dependent on Continental schools for this training, and at the present moment we have officers of the French forest service, who have been lent to the British Government, at the head of the forest administrations both at the Cape of Good Hope and at Cyprus. It seems, then, time that some stir should be made to help ourselves in this matter. It would, perhaps, suffice at first to establish a course of lectures on forestry at one of our public educational establishments, at which young men desirous of following a forest career might attend; provision being made for their instruction in practical work, if possible, in our own Crown forests, but otherwise, in some of the State forests on the Continent. It might be hoped that the Indian and Colonial Governments would, as an encouragement, place some appointments in their forest services at the disposal of young men so educated.

As a proof of what has been already effected in India by the forest officers educated in the Continental schools, I may mention that in that country there are at the present date 9,820,000 acres of reserved forests, the whole of which are managed generally on the principles above detailed, and 2,493,000 of which are protected from fire, as well as cattle and sheep grazing, and consequently, are now in a condition to reproduce themselves under the natural system; and as, perhaps, the most convincing proof, from a practical point of view, of the value of the system, I may add, that the forest revenue of India, which in 1870, was only £357,000, with a net revenue of £52,000, in 1880 reached £545,000, with a net revenue of £215,000. That is to say, the revenue had increased 56 per cent., while the charges had only increased 8 per cent.

In South Australia a serious commencement has been made in the right direction also. By an Act passed in 1873, the sum of £2 per acre is paid to landowners, in certain districts of the colony, to form plantations of trees. In 1875, a Forest Board was constituted, as certain districts of the colony were formally defined as forest reserves. In 1878, a Forest Act was passed, and a conservator of forests (Mr. Brown) was appointed. Last year, about a quarter of a million trees were planted out, and the forest revenue amounted to £6,517—of which £1,380 was for timber sold—against an expenditure of £6,200.

If then, so much has been done by the Indian and Colonial Governments to secure the future of their forests, can nothing be accomplished at the head-quarters of the Empire? This is the question now before us, and I trust that it may be answered, by instituting a course of instruction which may eventually develop into a forest school for Great Britain.

DISCUSSION.

Sir RICHARD TEMPLE, G.C.S.I., said he had great pleasure in standing by the side of his old friend and comrade, Colonel Pearson, who began his forest career under him some twenty years ago. They had together threaded the dense thickets of India, and admired the broad trunks, spreading branches, and magnificent heads of the forest trees, and though Colonel Pearson suffered a great deal from the malarious climate, he braved all dangers and hardships manfully for the sake of the forests he loved so well; and today there was no one more competent to speak on this important subject. There was not the same inducement to preserve the forests in England as in some Eastern countries, because here it was to a great extent a question of wealth, but in Eastern countries it was a question of climate also. Here, trees were preserved to a great extent for the sake of ornament, and as a shelter for game. As had been mentioned, England was naturally well endowed with trees, and to this he, as a small West country landowner, could bear testimony; but unfortunately, since the gales of last October, the timber which had strewed the ground had been rather a drug in the market. He could vouch for the excellent forestry which was carried out in Scotland, and all who had travelled on the Continent were aware of the excellent schools of forestry which existed both in France and Germany. He could not say much about Spain and Italy, but he had lately been through Denmark, which was as bare of trees as the palm of one's hand; on crossing over to Sweden, however, you came to a region where the trees were really preserved as a source of national wealth in the most perfect manner possible. In America, no doubt forestry was somewhat behind hand, and before long the eastern part would get into great difficulties unless more care was exercised. With regard to establishing a school of forestry in England, he did not see how it could be done unless there were State forests. He had examined the subject when in Scotland, where he delivered a lecture on the subject, and though there were magnificent forests there, the proprietors of which would no doubt allow facilities for their inspection by students, and for instruction being given by the foresters in whose charge they were, so far as possible consistently with their more immediate duties, these advantages would not be sufficient, unless the forests were absolutely under State control. If such a school were formed, there would no doubt be ample scope for the employment of the students in the eastern and other portions of the British Empire, and he was sorry Sir Bartle Frere was not present, for he was sure he would have borne testimony to the necessity of forest conservency in South Africa. Sir Samuel Baker could have given equally strong testimony with regard to Cyprus, which in classical times was one of the most lovely and fertile of islands, but was now in a wretched condition, and could hardly find means to pay its way. The main cause of its utter denudation in modern times was the destruction of its forests. He rejoiced at this subject being brought before that influential Society, for there were few matters of more importance to the future of India. The destruction of her forests in former times had been one of the blots on the administrative and statesmanlike escutcheon of England, and it had arisen simply from the ignorance of her governors, individually and collectively. When he went to India, he was supposed to have had a liberal education, but he had never heard a word about forestry, and he feared that many of those who came after him were not much better in this respect, though there might be some little improvement. There were great interests in India, all arrayed against the forests—all wanting to live upon them. Colonel Pearson had pointed out the difference between drawing an interest from the forest, and using up the capital, or *corpus*, as lawyers called it, which all selfish and shortsighted people were inclined to do; but it was the duty of the Government to come forward and protect forests, in the interests of the people themselves. If it had been neglected, it was simply because the Government had been uninformed, and for that reason alone he should hail with great satisfaction the establishment of a forest school in this country, as it would afford a means of difusing a knowledge of forestry amongst the civil servants of India. We had before our eyes the most frequent examples of the consequences of disforesting. What was the cause of Palestine, Syria, Asia Minor, and parts of Mesopotamia being so utterly barren and destitute, compared to what they were in ancient times? People attributed it to invasions and revolutions, but it was owing far more to disforesting. Many of the beautiful hills, which long before the Christian era were well clad, were now utterly bare, and thus the climate became affected, the rivers and harbours silted up, as was shown at Ephesus and the mouth of the river near Tarsus. Again the same thing was the cause of the fearful famines in China; the Chinese were excellent agriculturists; as regards manuring they were ahead of every nation in the world, but the art of forestry had been long extinct among them. He would not stay to speak in detail of the Indian famines, but having served through them, he could say that one of the causes, probably the main cause of the droughts, was the destruction of forests in past times. What England thought to-day India would think to-morrow, and, therefore, he hoped this subject would be heartily taken up. A great deal had been said of the French forest schools, and it should not be forgotten that they were due to the Emperor Napoleon III.

Mr. J. C. ROGERS said the Surveyors' Instituton, of which he was secretary, had for a long time taken a great interest in this subject, and when Dr. Brandis first established the Indian Forest Department in 1867, the council of that society made strenuous efforts, but without avail, to combat the notion that it was necessary to send all the students to France or Germany. They held that there were magnificent and well-managed forests in Great Britain, and that means might be found at home for educating the candidates for the Indian Forest Department; but a deputation which waited on the Duke of Argyll, then Secretary of State for India, met with a signal rebuff, and was informed that an inflexible rule had been laid down that all such candidates must attend the French or German schools. About 1875, the Institution drew up a number of questions, which were sent to the Colonial and Foreign Offices, asking for information as to the management of forests in the various European countries and in our dependencies, and about two years later a most alarming budget of information was received in reply, containing such a vast quantity of details, that it was impossible for any individual to deal with it. At length, in the summer of 1878, feeling ashamed that nothing was done with this very valuable information, he undertook to deal with that part of it which related to the British dependencies, and after six months' hard work, managed to compile a considerable book, containing all that was valuable in the returns, supplemented from other sources, and this book was published as a Parliamentary paper; but coming out at an unfortunate time, he feared that it had almost escaped public notice. He believed, however, that it was this publication which first called attention to the alarming evils with which they were threatened by the mismanagement of forests. He did not deal with India, as there was already a scheme in full operation there, but he dealt with all the colonies, and pointed out that South Australia was the only place in which any care was being bestowed on this question. In some places the periodicity of the rainfall had been greatly affected, and the ruthless destruction of the timber in the neighbourhood of settlements frequently caused great economic difficulties. In many cases colonies would be almost deprived of fuel altogether in case of a war, in which Great Britain temporarily lost her naval supremacy. This return had anticipated many of the statements of Colonel Pearson, and it had been freely quoted in several cases without the customary acknowledgment, though not on the present occasion.

Mr. John Robinson, as a forester of 40 years' experience, felt much obliged to Colonel Pearson for the capital paper he had brought forward; and he was particularly pleased to find he advocated the establishment of a school of forestry in England. Sir Richard Temple had spoken of the wealth of England in this department; but no man ought to be allowed to throw away his wealth, as was done here, merely by the neglect of plantations which had been started. In many parts of England, and in some parts of Scotland, it would be found that plantations which had been made at the Government expense had failed, from the incompetency of those who managed them. He remembered, some years ago, reading in a paper on this subject, the pith of which was contained in these few words "Plant thickly, thin quickly." The nurserymen took care that the first injunction should be obeyed, but the other part was generally neglected. Like the last speaker, he had been endeavouring for some years past to induce the Government to take up this question, and he hoped he had attained a certain amount of success with the late administration; but just then a change came, and nothing was done. He did not think it was altogether hopeless to establish a school of forestry in Edinburgh, where there were already facilities for affording the young forester information in the cognate branches of his education, such as geology, botany, &c., and an arboretum had recently been purchased by the municipality, and his contention was, that if the Government would endow a professor of forestry, the thing might be accomplished. Something was being done by Sir Joseph Hooker at Kew, and he hoped that one result of this paper would be the formation of a committee which should make renewed efforts to induce the Government to take the matter up, and establish a school of forestry in Great Britain, not only for the sake of India, but also for the instruction of land agents and others who had to manage estates at home, so that the largest amount of profit might be obtained from the numberless forests in our own country.

Mr. Thistelton Dyer, F.R.S., thought it was desirable to keep as much as possible to the point raised by the paper, and though Mr. Robinson's remarks were very suggestive, he feared they had a tendency to raise a cross issue. The British Empire covered a large part of the surface of the globe, and the real problem was how to arrange that the forest resources of the different countries under our charge did not suffer such a deterioration as would, on the one hand, injuriously affect the climate of those countries, and on the other deprive our fellow subjects in the future of the material resources obtainable from those forests. No one who had studied the information which had been gradually acquired on this subject, could doubt that there was grave cause for anxiety. You could not go on felling forests indefinitely without producing an artificial state of things which, if not watched with care, would ultimately produce complications of the gravest kind. He had listened with great interest to the remarks of Mr. Rogers, and he could assure him that his work was by no means thrown away. A copy of his book was amongst the papers at Kew, and he felt that it was a document of the greatest importance with reference to the statistics of this subject; and when the question gradually ripened into a shape in which it would attract the attention of political persons, it would be referred to as the starting-point from which any action should be taken. The alteration of the surface of occupied countries, and the removal of forests, required to be approached with some caution. For instance, in England it was not a very pressing question; and though he had seen a paper drawn up for the India-office by one of the professors of the school at Nancy, in which it was stated that Scotland had once 20 million acres of forests, whereas, now there were but three-quarters of a million, he did not know that the material prosperity of Scotland had suffered by the change. You could not lay down a broad principle that the removal of woods in temperate climates must be regarded as a disaster. On the other hand, in the south of France the removal of the forests from some of the Alpine slopes, in the interest of agriculture, had lead to disastrous floods; one of which, in 1875, caused damage to the extent of £3,000,000, and the Government was now going to great expense to replant those slopes. This was a question which most affected our fellow-citizens in the hotter portions of our possessions. Cyprus had already been mentioned, and it was in many respects a typical instance. He did not know how far it could be taken as true that the island was once covered with forests; but, at present, such as were left, were in the last stage of dilapidation. A report had been made upon them by an Indian forest officer, who was of opinion that, within the present generation, what remained of the forest would probably perish. The rainfall was only thirteen inches, and it immediately flowed off the surface, so that, in the language of the report, instead of a forest you had a desert. A French forester, who was selected by Colonel Pearson to go there, estimated that with a quarter of a million outlay something might be done in half a century; but where was the money to come from? When the forests of such a country as Cyprus were destroyed, it was like a burnt cinder. Many of the West Indian islands were in much the same condition, and the rate with which the destruction took place when once commenced was almost incredible. In the Island of Mauritius, in 1835, about three-fourths of the soil was in the condition of primeval forest, viz., 300,000 acres; in 1879 the acreage was reduced to 70,000; and in the next year, when an exact survey was made by an Indian forest officer, he stated that the only forest worth speaking of was about 35,000 acres. Of that, the portion in the possession of the Crown had had every stick of available timber cut, and those parts in the possession of private owners were still worse. Although there had been no apparent diminution in the rainfall, the humidity of the air had diminished, and the springs were drying up. Again, taking Ceylon, in 1873, Sir William Gregory, ascending a mountain in the centre of the island, 8,000 feet in height, said the eye ranged in every direction over an unbroken range of forest; but six years later, when the present governor made the same ascent, the whole forest had disappeared, and the ground had been parted with so rapidly by the Government that it had not even retained sites for police-stations, and had to re-purchase them. In Jamaica, again, it appeared that nearly all the timber required for building purposes had to be imported. In Ceylon, the denudation of the forests was accompanied by a deterioration in the soil; and the Rev. R. Abbay, who went there on the eclipse expedition, calculated, from the per-centage of solid matter in a stream, that one-third of an inch per annum was being washed away from the cultivated surface of the island. In some colonies the timber was being destroyed at such a rate as would soon lead to economic difficulties. In New Brunswick, for instance, it appeared that the hemlock spruce, the bark of which was used for tanning, was rapidly disappearing, one manufacturer in Boiestown using 100,000 trees every year for this purpose. In Demerara, one of the most important and valuable trees, the green heart, was in a fair way of being exterminated. They actually cut down small saplings, to make rollers on which to roll the large trunks. In New Zealand, again, Captain Walker said he feared the present generation would see the extermination of the kauri pine, one of the most important trees. All these facts showed that this was a most urgent question which at no distant date would have to be vigorously dealt with. Mauritius, Cyprus, and Ceylon had obtained the assistance of the Indian Forest Department, but it must be remembered that the gentlemen of that department had duties of their own to perform, and there would be an increasing difficulty in getting the requisite assistance from that quarter. Then there were those who were educated at the French school, but there were certain disadvantages in employing the services of foreigners in English dependencies. Lastly, a certain number of men from Kew had been utilised, and he was glad to say that their efforts were highly spoken of, but it must be remembered that they had not had such advantages as were desirable in forest officers, so that none of these sources seemed likely to be able to give a permanent supply of the men that were required, and hence it was manifest that some new establishment was urgently needed.

Mr. **Hyde Clarke** said he believed this subject had been taken up by the Society a century ago; and he was convinced that if a representation were made to the Council, a committee would be appointed, which would probably lead to some practical result. His memory did not quite bear out what Colonel Pearson had said with regard to their past deficiencies in this respect; he had alluded to the history of the subject in the time of Queen Elizabeth, and he believed it would be found that continuous attention had been given to the production of timber in this country for various purposes. He might remark, also, that some of their friends from India were sometimes inclined to press the matter too far. Sir Richard Temple had referred to Ephesus, but he (Mr. Hyde Clarke) could by no means trace the silting up there to the destruction of the forests. He did not believe the forests were ever greater in that district than they were now; and with regard to the southern parts, he had had a great deal of timber from those very forests.

Mr. Boulger remarked that there was the same encouragement in England for the establishment of a school of forestry as had been operative in America, viz., the willingness of private individuals to avail themselves of its advantages, of which he could speak from personal experience. In 1876, when he was at the Agricultural College at Cirencester, he was requested to deliver a course of lectures on sylviculture, preparatory to the examination of the Highland Agricultural Soctety of Edinburgh, and he then gave what he thought must have been the first course of lectures on the subject ever delivered in England. In Oxford there had been for 200 years a professor of botany and rural economy, but he feared the latter subject had been swallowed up by the former. At the present time the students of forestry in England laboured under great disadvantages, for even at Cirencester, thought he was in the same county as the Forest of Dean, he was too far off to take his pupils for any practical work to that admirably managed forest. As Colonel Pearson had said, for a forest school you require a State forest; such did not exist in Scotland, and he hardly thought a newly-established arboretum could take its place. A wood was one thing, and a forest another; the Forest of Dean was a State forest, and possibly arrangements might be made for teaching forestry in connection with Cirencester College. At present time forest officers went to India from this country at the rate of six per annum, which was not a large number. They were educated at first, mainly in London, and a great many had passed under his hands during the last three years, to be promoted in scientific subjects, but such work was eminently unsatisfactory, seeing that the plane trees in the London squares were the principal illustrations at command. Then they went to Nancy, where they had to hear lectures in a foreign language, and though no doubt the proficiency they were compelled to attain in French was an advantage, the system had many drawbacks. He learned from some of his pupils that they had to begin all their science over again in French. This difficulty would be removed by the establishment of a forest school in England, and he believed that some of the French forest officers had testified to the admirable way in which the Forest of Dean and other State forests in England were managed. After all, the principles of forest cultivation were the same all the world over, though there might be differences of climate and species to take into account.

Mr. Liggins said he remembered in his early days, in the West Indies, there was a great controversy as to the proper way of dealing with the forests, one side maintaining that all the trees should be cut down to prevent the roots interfering with the canes; whilst others contended that if the trees were destroyed, there would be no rain, and they would get no crops at all. He had naturally taken a great interest in the subject ever since, but was never able to learn anything about it in this country; whereas, in visiting the last Paris Exhibition, he found there was abundant information attainable. He might state that timber for buildings was not imported into Jamaica because there was none in the island, but because the native timber was so valuable, hard, and expensive to work, that it was cheaper to import pitch-pine and other soft wood. He could not altogether agree with Mr. Boulger that London was such an unsuitable place for teaching science; a great deal might be learned here where men of every science met together, and the student would have his mind fertilised generally. An immense deal of mischief had been done in Demerara, Barbadoes, and other West Indian Islands, from the destruction of trees, and it was most desirable, in the interest of all the colonies, that a central school should be founded where young men might be trained in this most important branch of knowledge.

Mr. William Botly said he had the authority of one of the largest agriculturists of this country for the statement that there were thousands of acres on the sides of hills and slopes which might be advantageously planted with trees at a cost of £10 to £12 an acre, which would yield a handsome profit. He had known two instances in which the timber on an estate had been sold for nearly as much as the whole purchase money, and having had some experience in planting, he was very well satisfied with the results.

General Strachey, C.S.I., F.R.S., said he might almost consider himself the dry nurse of the Indian Forest Department, having assisted at its birth, and watched its development into one of the most successful branches of the administration. The Indian Government, under the pressure of necessity, had developed this department; it had required its officers to study at Nancy, acting under the advice of Dr. Brandis, and the system had so far proved very successful. But, as had been remarked, there were obvious disadvantages connected with the system, and for some time it had been the desire of the Indian Government to obtain for its forest officers the necessary education in England. That idea was about to be acted upon, and no doubt before long a school would be established here, whether the Home Government joined in it or not.

Mr. Rowland Hamilton hoped the suggestion of Mr. Hyde Clarke would not be lost sight of. The subject would attract the attention of many other societies, such as the Colonial Institute, the Statistical, and Agricultural Societies, and the Social Science

Association, who would all aid in bringing the matter under the notice of Government, if the Society of Arts appointed a committee to deal with it.

The CHAIRMAN, in proposing a vote of thanks to Colonel Pearson, referred to the statement that the net revenue from the forests of India had been increased during the last ten years by £200,000, in great measure by the effects of the Indian Forest Department; and as that Department had been so greatly aided by Colonel Pearson, they owed him a double debt of gratitude. Some advantage might perhaps, be derived from the present depression in agriculture, if it forced those who were dependent on the land for their income to consider whether they might not do much to improve its value by the establishment of schools and colleges for instruction in agriculture and also in forestry. Even in Scotland, although the forests were generally well managed, there seemed a general consensus of opinion that there were large tracts of country which might be planted with advantage. It certainly was an anomaly that a country like England, which owned some of the largest forests in the world, was the only great country which had no forest school; and it would no doubt be a great satisfaction to Colonel Pearson if the discussion that evening should prove the first step towards the establishment of a forest school worthy of the British Empire.

The vote of thanks having been carried,

Colonel PEARSON, in reply, said he was much gratified by the cordial reception which had been accorded to his paper. He must tell Mr. Rogers that his paper had been very much appreciated in France, for it had been tabulated and re-tabulated by the professors at Nancy, and used in their lectures, and questions were set upon it; and there was no doubt that if a forest school were established in England that return would form one of the principal documents referred to. He would point out that such a school would have to do a double work, though it might be connected, partially, at any rate. A certain amount of instruction was needed by surveyors and land agents who were to practice in this country; but those who were to go to India and the Colonies must be provided with a wider scientific training than would suffice in the former case, where any information on special points connected with mineralogy, geology, &c., could be obtained without difficulty when required.

Miscellaneous.

ROYAL COLLEGE OF MUSIC.

A meeting, presided over by H.R.H. The Prince of Wales, was held in the Banqueting Hall, St. James's Palace, on Tuesday, February 28th, for the purpose of soliciting public support for the project of founding a Royal College of Music. The PRINCE OF WALES, after reading letters from the Duke of Connaught and Prince Christian expressing regret that they were unable to attend, said—My Lords and Gentlemen, I have called you together to-day, the representatives of the counties and towns in England, the dignitaries of the Church and other religious and educational bodies, distinguished colonists now resident in England, and the representatives of foreign Powers, to aid me in the promotion of a national object by obtaining contributions for the establishment of a Royal College of Music. Were the object less than of national importance, I should not have troubled you—the heads of social life—to meet me here to-day, and I should not, myself, have undertaken the responsibility af acting as the leader and organizer of the movement. I have invited to meet you the leading musicians and publishers of music, the most eminent musical instrument makers, the most influential amateurs and patrons of music, and I trust that by the co-operation and union of these, the most powerful elements of society, we may succeed in establishing a Royal College of Music on a more extended basis than any existing institution in the United Kingdom; worthy alike of this meeting, and of this country, for whose benefit you are asked to give your time, your money, and your influence. I do not propose to trouble you with any proofs of the advantages that would be derived from the establishment of a National College of Music. The subject has been fully discussed by the Duke of Albany at Manchester, and his address is before the world. He showed that, relatively to foreign countries, England occupied three centuries ago a higher place in the musical world than she does at the present time, and he proved that the almost universal establishment of central and national musical institutions abroad, and the want of such an institution in England, had been the cause why musical progress has not in this country kept pace with the increase of wealth and population, and the corresponding development of science and art. Again, the necessity of public aid formed the groundwork of the appeal made at Manchester by the Duke of Edinburgh and Prince Christian. Music, as they showed, is far more expensive to teach than other arts, and the natural capacity for instruction in music is more rare than in almost any other art. You are compelled, then, if you would have good musicians, to provide means by which those to whom nature has been bountiful in giving good ears and good voices, but niggardly in giving worldly wealth, may be sought out in their obscurity, and brought up to distinction by a proper course of instruction. What I have said naturally leads me to deal with free education in music, coupled, in certain cases, with free maintenance of the pupil, as the first branch of the subject on which I desire to engage your sympathies and ask your aid. This system of gratuitous education is one of the principal features which will distinguish the new college from the Royal Academy and other excellent existing schools of music. I do not mean to say that we intend to exclude paying pupils. To adopt such a course would be to deprive musical ability in the upper classes of any means of access to the college, and would stamp it with a narrow and contracted character, which is above all to be avoided in a national institution intended to include in its corporate character all classes throughout the United Kingdom. What I seek to create is an institution bearing the same relation to the art of music as that which our great public schools—Eton and Winchester, for example—bear to general education. His Royal Highness then gave an outline of the details of the scheme, and expressed a hope that he would be able shortly to give further details of the foundation and establishment of the college.

The following resolution was proposed by H.R.H. the DUKE of EDINBURGH:—"That this meeting approves of the proposal to establish a Royal College of Music as a national institution, and undertakes that meetings shall be called throughout the country, and the utmost exertions used, individually and collectively, to forward the movement by obtaining the necessary funds for founding and endowing a College of Music for the British Empire."

The resolution was seconded by the ARCHBISHOP of CANTERBURY, and supported by the EARL of ROSEBERY and the LORD MAYOR.

Mr. GLADSTONE moved:—"That the thanks of the meeting be respectfully offered to his Royal Highness the Prince of Wales for having summoned this representative meeting, and for the promise which his Royal Highness has graciously made, that the establishment of the college shall be under his own mmediate control and superintendence."

Sir STAFFORD NORTHCOTE seconded the motion, which was carried by acclamation.

Correspondence.

NEW VARIETY OF SILK-MOTH.

On behalf of both entomologists and sericulturists, it seems desirable to make some further mention of the fertile hybrid silk-moth—result of a cross between the *Yamma-mai* of Japan, and the *Tusser* moth of the Deccan—first produced at Bombay about seven or eight years ago (see *ante*, p. 349). It is not mentioned by Mr. Wardle in his valuable "Handbook of the Collection Illustrative of the Wild Silks of India," though that bears date so late as July last year. Besides, this new silkworm, though specially reared, comes under the definition given by Mr. Wardle in his opening sentence:—"The term 'wild silks of India' must be regarded as applying to all species of silk other than that produced by the *Bombyx mori*, the worm which feeds on the mulberry leaf." The primary advantage of this new high-class silk-spinner is in its being able to feed and thrive, not only on the bhair tree (*Zizyphus jujuba*), as mentioned in my remarks the other day, but on almost every variety of the *ficus*—probably on all the trees mentioned by Mr. Wardle (p. 15) as furnishing food to the "Tusser" worm. Thus the new worm might be diffused over the greater part of India without any planting preparations being required. The Japanese progenitor of the hybrid is known as the "oak-feeding" silkworm; so that may partly account for the omnivorous character of the creature, although experience may show that carefully selected diet will improve the quality of its silk. The new variety might be provisionally designated *Yamma-paphia Mowisia*, thus preserving the name of the ingenious sericulturist, Mr. Paul Mowis, who developed the hybrid, and tested its value through several seasons. Having, myself, seen the creature during all its stages, from egg to moth, I can testify to its healthy appearance, its fertility, and productiveness. Some millions of its cocoons were, I understood, sent about 1878, to be reeled and worked up at Bradford. The silk is finer than that of the Tusser, and nearly as strong; so that if the worm can be reared and fed on the same plants, and with as little trouble as the coarser Tusser worm, then there should be a very distinct gain in the more valuable quality of silk produced. Mr. Mowis is, at present, carrying on his sericulture somewhere in the railway reserved forests of H.H. the Nizam's dominions; and, no doubt, information could be elicited from him on the subject. He had given much attention to the practical chemistry of sericulture in trying to hit on the best methods of removing the mucilaginous matter from the worms, and in preparing the fibre for dyeing.

Sir George Birdwood's old report (1859-60) on the Tusser and other wild silks of the period (reprinted by Mr. Wardle), though in some respects superseded, gives useful indications of the spirit with which this promising industry should be fostered by the Bombay Government.

W. MARTIN WOOD.

West Kensington, February 27th.

General Notes.

LONDON SANITARY PROTECTION ASSOCIATION.—The first annual general meeting of this Association was held on Saturday, Feb. 25th, in the rooms of the Society of Arts. Professor Huxley, the President of the Association, took the chair, and read the annual report, which stated that at the end of 1881 the Association had 192 members, 22 of whom were medical men, who had joined in respect of their own houses. The need of inspection was shown by the fact disclosed by Mr. Burton's report that 6 per cent. of the houses inspected during the year were absolutely pestiferous, and it was by a marvellous chance that they had not been hot-beds of disease. In a much larger proportion of cases of inspection, more than two-thirds of the whole, there were, it appears, general defects in the drainage arrangements which were very dangerous to children or delicate adults. He moved the adoption of the report and balance-sheet. Mr. Timothy Holmes (the hon. treasurer), in presenting the balance-sheet, which showed a balance in hand of £74 at the end of 1881, said, that in the first two months of 1882, 42 new members had joined, and only two of the old members had left the Association, so, at the moment of speaking, the Association numbered 232 members, and had a balance of £100 in the bank. The meeting was addressed by Professor Fleeming Jenkin, Sir William Tyrone Power, Mr. E. C. Robins, the Hon. and Rev. Mr. Freemantle, Dr. Lauder Brunton, and Dr. Pearson, of Kensington. It is announced that the report of this meeting will be printed in *extenso* shortly, and that a copy will be sent to any London member of the Society of Arts, ratis and post free, on application to the Secretary, London Sanitary Protection Association, 7, John-street, Adelphi, W.C.

GOLDSMITHS' COMPANY'S PRIZES. — The programme for the eleventh competition (1882) has just been announced. With a view to the encouragement of technical education in the design and execution of works in the precious metals, the Goldsmiths' Company of London offer two prizes of £70 each; three of £35; three of £25; two of £20; six of £15; and six of £10. Everything offered for competition must have been made within the present year, and by a British subject, and the prizes will only be given to the actual executants. The Company have also resolved that a travelling scholarship of £100 may be awarded by the Wardens to a student who shall have obtained prizes for design or modelling in three years' competitions, in order to enable him to study art in the precious metals on the Continent of Europe.

STORAGE OF ELECTRICITY.—*Nature* states that M. Planté has found that the long process of "forming" his accumulators is shortened if they are warmed during charging. The temperature best for this purpose is between 70 deg. and 80 deg., at which limit the opposing electromotive force is somewhat less than when cold, and the resistance a great deal less. He does not find it advantageous to exceed this limit. The reason for this is, in the opinion of the writer in *Nature*, that at boiling-point the oxygen and hydrogen are evolved in normal conditions, no ozone being produced. The electromotive force of oxygen against hydrogen is less than than that of peroxide of lead against metallic lead, and far less than that of ozone against "nascent" hydrogen.

ROSE CULTURE.—Mr. J. C. Geiselbrecht, a member of the Society, writes that the "Attar," commonly called "Otto of Roses," is sold in London at less than in Paris; the wholesale price ranging at present from £20 to £28 per lb., according to quality. The Kezanlik Valley, which is one vast rosary, is situated south of the Balkans, in that part of the old Turkish province of Roumelia which is now merged in the principality of Bulgaria.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

MARCH 8.—"Improvements in Gas Illumination." By Prof. A. VERNON HARCOURT, F.R.S. Dr. ODLING, F.R.S., will preside.

MARCH 15.—"Gas for Lighthouses." (Illustrated by an Exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM. Prof. TYNDALL, F.R.S., will preside.

MARCH 22.—"Telephonic Communication." By LIEUT.-COL. C. E. WEBBER. The Earl of CRAWFORD AND BALCARRES, F.R.S., will preside.

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A. Dr. W. J. RUSSELL, F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

MARCH 9.—Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. BURTON. J. SPILLER, F.C.S., Vice-President of the Photographic Society, will preside.

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON, F.C.S. Dr. J. H. GILBERT, F.R.S., will preside.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

APRIL 21.—"The Mineral Resources of India, and their Developments." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Third Course will be on "Hydraulic Machinery," by Prof. JOHN PERRY.

LECTURE I.—MARCH 6.

The hydraulic press. The nature of fluid pressure. Compressibility of water. The law of work in machines. Hydraulic jacks, punches, shears and rivetting machines. Pressing machinery. The influence of friction. Bursting pressures.

LECTURE II.—MARCH 13.

Water at rest and water in motion. The energy law. Gauge notches. Centrifugal pumps and fans. Flow of water in pipes. Steam pumps and other reciprocating pumps.

LECTURE III.—MARCH 20.

Water-wheels and pressure-engines. Turbines. Measurement of the horse-power given out. Loss of power by friction. Hydraulic fittings, pipes, valves, &c. Accumulators, cranes, and hoists.

LECTURE IV.—MARCH 27.

Lifts. The new balance method, as applied in bridges, canal boat, and other lifts. The transmission of power to machines at a distance by means of water. Applications to various tools. Comparison of hydraulic and electrical methods, and the part which each is likely to play in the future.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. John Perry, "Hydraulic Machinery." (Lecture I.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. James Howard, "Local Rates as they Affect the Farmer."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C. 8 p.m. Mr. J. E. Howard, "The Supernatural in Nature."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. James Geikie, "The Ancient Glacier System of Europe."

TUESDAY, MARCH 7...Royal Institution, Albemarle-street, W., 3 p.m. Prof. McKendrick, "The Mechanism of the Senses." (Lecture VIII.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 52, Great George-street, Westminster, S.W., 8 p.m.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. Mr. E. H. Man, "The Aboriginal Inhabitants of the Andaman Islands" (with Lime-light Illustrations from the Author's Photographs).

Biblical Archæology, 9, Conduit-street, Hanover-square, W. 1. M. P. le Page Renouf, "Egyptian Mythology—Mist and Cloud." 2. Mr. W. Flinders Petrie, "Notes on Pottery and Implements collected at Giseh." 3. Mr. A. L. Frotheringham, jun., "Notes on an Hebrew Inscription at Ravenna."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. W. A. Forbes, "Some points in the Anatomy of the Great Ant-eater." 2. Dr. Hans Gadow, "The Anatomy of *Pterocles*, with Remarks on its Systematic Position."

WEDNESDAY, MARCH 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. A. Vernon Harcourt, "Improvements in Gas Illumination."

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Mr. W. Ewart, "Pulmonary Cavities, their Origin, Growth, and Repair." Lecture II.)

Geological, Burlington-house, W., 8 p.m.

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m. Anniversary.

Institute of Bankers, in the Theatre of the London Institution, 6 p.m. Sir Richard Temple, "India; the Purchasing Power of the Rupee Relative to Labour, Produce, &c."

Sanitary Institute of Great Britain, 9, Conduit-street, W., 7¾ p.m. 1. Presentation of the Prize of £200 for an Essay on the "Range of Hereditary Tendencies in Health and Disease." 2. Paper on th subject, by Mr. George Gaskoin, the author of the Prize Essay.

THURSDAY, MARCH 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. W. K. Burton, "Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. An Art Lecture by Mr. W. F. Yeames.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. Cave Thomas, "The Science of Proportions in Relation to Architecture."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. L. Sclater, "The Geographical Distribution of Animals." (Lecture IV.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. Professor Woolsey Johnson, "Systems of Formulæ, &c." Two Notes by Mr. C. Bickmore.

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Dr. W. H. Stone, and Dr. W. J. Kilner, "Measurement in the Medical Applications of Electricity."

FRIDAY, MARCH 10...Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Mr. W. Ewart, "Pulmonary Cavities: their Origin, Growth and Repair." Lecture III.

Royal United Service Institute, Whitehall-yard, 3 p.m. Major-General Sir Henry M. Havelock-Allan, "Mounted Infantry: Past and Future."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly meeting, 9 p.m. Mr. J. W. Swan, "Electric Lighting."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. 1. Mr. Brinsley Nicholson, "Was Hamlet Mad?" 2. Mr. W. G. Stone, "As You Like It."

SATURDAY, MARCH 11...Geologists' Association, 2½ p.m. Visit to the British Museum (Natural History), Cromwell-road, South Kensington, and a Demonstration on the Collection of Meteorites, by the Director, Mr. L. Fletcher.

Physical, Science Schools, South Kensington, S.W., 3 p.m.

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Watkiss Lloyd, "The Iliad and Odyssey." (Lecture IV.)

Journal of the Society of Arts.

No. 1,529. Vol. XXX.

FRIDAY, MARCH 10, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor John Perry delivered the first lecture of his course on "Hydraulic Machinery" on Monday, 6th inst. He commenced with a description of the hydraulic press, the nature of fluid pressure, the compressibility of water, and the law of work of machines. The application of hydraulic power to jacks, punches, shears, rivetting machines, and pressing machines was described, and an account of the influence of friction and bursting pressures. The lecture was illustrated by experimental apparatus, lent by the City and Guilds of London Technical College, Finsbury, by hydraulic presses, jacks, and bears, lent by Messrs. Tangye Brothers and Holman, and by diagrams lent by the Institution of Mechanical Engineers.

SOCIETY OF ARTS' PATENT BILL.

The Right Hon. W. H. Smith has consented to take charge of the Society of Arts' Patent Bill, in conjunction with Sir John Lubbock, who, as announced in last week's *Journal*, had previously undertaken to introduce the Bill into the House of Commons.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefit of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, in the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1873, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

The Council invite members of the Society to forward to the Secretary, on or before the 22nd of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 8th, 1882; Dr. ODLING, F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Beetham, Arthur, 1, South-square, Gray's-inn, W.C., and 4, Leigh-road, Highbury, N.
Harben, Alfred, 3, Melita-villas, Victoria-road, Charlton, S.E.
Jowitt, Albert, Hawthorne-lodge, Clarke-house-road, Sheffield.
Lever, Ellis, Bowden, Cheshire.
Young, Lieut.-Colonel John Richard, 20, Windsor-terrace, Newcastle-on-Tyne.

The following Candidates were balloted for and duly elected Members of the Society:—

Chandler, Josiah, 104, Newington-causeway, S.E.
Chandler, Samuel, 104, Newington-causeway, S.E.
Cottell, G. Lansdowne, 6, Tavistock-square, W.C.
Davies, Ferrand, 148, Gresham-house, E.C.
Duncan, James Morison, 21, St. Ann's-villas, Notting-hill, W., and 70, Queen-street, E.C.
Field, James John, North-lodge, New Barnet, Herts.
Forward, Henry, 3, Burr-street, E.
Hill, Arthur, Hayes-common, Kent.
Langdon, William Edward, Telegraph Department, Midland Railway, Derby.
Lorrain, J. G., 2, Victoria-mansions, Westminster, S.W.
McMillan, Walter George, F.C.S., 104, Jermyn-street, S.W.
Reynolds, Lieut. John H., Guards' Club, S.W.
Ullyett, Arnold Henry, Lyell-house, Folkestone.
Wood, Charles George, 4, Talbot-place, Blackheath, S.E.

The paper read was—

IMPROVEMENTS IN GAS ILLUMINATION.

By A. Vernon Harcourt, M.A., F.R.S.
Lee's Reader in Chemistry at Christ Church, Oxford.

The discovery of better methods, and the invention of better machinery, for converting mechanical into electrical energy, has led, within the last five years, to the application of the electric arc to the illumination of streets and large public buildings. Almost within the last year the incandescent thread of carbon in a vacuous globe, to which several ingenious minds and skilful fingers have given slightly different forms, has appeared as an indoor illuminant, and at once commended itself by the silent, steady glow of its brilliant clusters. Gas-lighting, which has become universal wherever two or three hundred men live in neighbourhood, and has had a prosperous unchallenged existence for nearly seventy years, has now the stimulus of an attractive, perhaps formidable, rival in its sphere of public service. It would be far from the truth to suppose that the appliances for private and public gas-lighting were remaining without improvement until recently; but invention is stimulated by competition; and, in particular, the taste for brilliant out-door illumination, which used only to be gratified on occasions of national rejoicing, has been excited by displays of the electric light; and thus rival shows of illumination by gas have had to be provided, and the means for producing them invented.

The Council of this Society, having on several occasions brought before their members and the public the improvements which have been made in electric lighting, wish in turn to bring under discussion the recent advances which have been made in gas-lighting, and with a view to this I have been asked to prepare a short paper on the subject. From manufacturers such as Mr. Sugg and Mr. George Bray, to whose energy and inventiveness these advances are mainly due, and from managers and inspectors who have that familiarity with the needs and means of public lighting which having to do with it confers, I must ask indulgence in the execution of this task. I can do little more than propose questions which they are best able to answer, and make suggestions to which, if any deserve it, they must give a practical form.

Remarks on gas illumination fall naturally under two heads—domestic and public illumination.

In reference to domestic gas-lighting, such questions as the following arise :—Is gas objectionable in sitting-rooms or bedrooms, on account of the heat and the chemical products which its combustion generates ? What form of burner is best ? Are a few large burners, or several smaller ones, to be preferred ? Where should the burners be placed in a room—on a central pendant, or on brackets ? How should the gas be regulated, that the desired amount of light may be obtained constantly, and from the minimum quantity of gas ?

The objection to gas on account of the heat caused by its burning, and the preference accorded to electricity on that ground, is difficult to understand. In this country there are often not twenty evenings in the year when a little fire would not be welcome; on such evenings only is the warmth of gas a disadvantage. For the rest of the year, it is a benefit to have several small sources of heat distributed about a room. The products of combustion would be better away; but since these products are gaseous, and rise at once to the ceiling, they pass quickly out from a well-ventilated room. A great improvement in the comfort of sitting-rooms, however lighted, would be the general adoption by builders of a flue by the side of each chimney, opening below just under the ceiling, and above into the roof-space. Where such an escape for hot air is provided, gas-burners act like the fire at the bottom of an upcast shaft, and promote the ventilation of a room.

The chief defect of gas, as compared with candles and lamps, and now with the incandescent light, is want of steadiness. A fish-tail in a glass globe, with a two-inch opening beneath, which is the most common gas-burner in a sitting-room, gives a light so wavering and tiring to the eyes that it must have done much to make gas unpopular. A naked flat-flame, or one surrounded by a globe with a wide opening beneath, is much steadier. Such a burner cannot, however, combine maximum steadiness with maximum development of light from the gas consumed; and where flat flame burners are used in a room, a loss of 20 per cent. of light is not too great a sacrifice for the sake of a steady flame. The numbers on the tables in the Appendix, which show the power possessed by each burner of developing light, do not take account of differences in steadiness, and must not, therefore, be taken as fixing absolutely the order of merit of the burners thus compared.

A good Argand burner gives as steady a flame as a fishtail burning with the most suitable pressure does, and it developes 30 to 40 per cent. more light from every cubic foot of gas consumed. That is to say, for any required amount of steady light, 30 or 40 per cent. less gas has to be burnt and paid for when the Argand burner is used. Such a difference would probably balance in a single year the greater cost of the Argand burner. The Silber burner and the smaller Argands sent here by Mr. Sugg are good examples of such burners. The relative amounts of light developed by these are shown on Table I, which contains the results of a few from among the large number of testings made and reported in 1880 by the British Association Committee, and on Table II., which gives the results of some testings which I have made recently. Of their relative steadiness, those who see them can judge.

A further question remains as to the globe, or other transparent casing, which is commonly placed round the flame. Where only a moderate light is needed, as, for example, in a dining-room, a shade of opal glass above the flame, with a smaller inverted shade beneath, such as are made to accompany both the Sugg and Silber Argand burners, leaves little to be desired. But in lighting a sitting-room so that, by night as by day, one can read with comfort in any part of it, without an excessive consumption of gas, the sacrifice of 50 or 60 per cent. of the light which the burners develop can ill be afforded. An Argand flame, surrounded only by its chimney, is dazzling if looked at near. Any novelty in lighting is likely to be judged unfavourably by those who are not familiar with it, not simply from conservatism, but because they do not use the light, but look at it. The chief sufferer from this cause has been, no doubt, the electric arc. If the sun were a novelty, those who had been out to see it would return declaring that its brilliancy was intolerable, and that, after looking at it for a moment, they had scarcely been able to see at all. When a bright light is no longer novel, and is sufficiently raised above the level of the head, the eyes instinctively avoid it, while seeing well the objects upon which it falls. It is, however, among the things to be aimed at, to send forth light from a relatively large surface of low intensity rather than the same amount of light from a small surface of more concentrated brightness. To do this economically may be impossible. Both with gas flames and with the electric light greater yield of light is obtained most cheaply by increasing intensity rather than surface. In gas-lighting, a similar amount of loss is experienced, from different causes, whether the diffusion of the light got from a given quantity of gas be effected by surrounding the flame with a translucent globe, from the surface of which a part of the light is uniformly emitted, or by burning the gas from several small jets, each yielding a thin flame of low intensity. The access of air to flat-flame burners cannot be regulated by the maker, and the greater efficiency of a well-made Argand depends in a great degree upon the control which the maker can exercise, by the dimensions of the chimney and the construction of the base of the burner, upon the amount of air to be admitted. If an Argand is turned down without the air supply being at the same time diminished, a great loss of light occurs. When the London Argand is burning half its normal supply of gas, it yields a light of $2\frac{1}{2}$ candles instead of 16. But if the air supply were proportionately reduced, nearly the original amount of light could be obtained from each cubic foot of gas consumed. This may be illustrated by turning down a Silber's Argand, and then diminishing the lateral opening by which air is admitted. The effect can hardly be distinguished from that of turning on more gas. If the makers of burners can produce Argands consuming only between two and three cubic feet of common gas, and giving, from a relatively large flame of moderate intensity, a steady light of seven or eight candles, an ordinary sitting-room, of 20 × 15 feet, would be excellently lighted by four or five such burners with chimneys only placed on brackets round the room, at a height of seven feet. Simple brass brackets, without globes, have the advantage of remaining unnoticed during the day-time; and brackets appear to me preferable to pendants, except for a dining-room, as furnishing here and there an appropriate light to writing-table, or sofa, or pianoforte, or picture, placed against or near any part of the wall, and helping to make the whole room look habitable, by spreading light evenly over it.

It is well known that the light given by a flat-flame burner which has been turned down low, and is attached to a pipe with a high gas pressure of $1\frac{1}{2}$ or 2 inches, first increases, as the tap is gradually turned on, until the point of maximum efficiency—at which the greatest amount of light is obtained for the volume of gas burnt—is reached; and still increases, but in a less ratio than the consumption of gas, for a further period; then diminishes, roaring or distortion of the flame generally giving warning that the final stage has been reached. To secure that any burner shall do its best without the need of adjusting the tap, and in spite of the variations of pressure in the street-main, the gas supply must be regulated. This may be done either at each burner or where, as is commonly the case, several burners draw their supply from the same system of pipes, at the inlet of that system. For street lamps, and often in private houses, where the consumption of gas is too great for the service-pipes, "governor-burners" must or should be used. With too small service-pipes the general reduction of pressure to the minimum pressure at which gas is supplied, will cause those lights to be dim which need as much gas as can be got to them.

But where proper service-pipes have been put in, and no burners requiring a high pressure are used, the simplest plan is to attach to the house meter a regulator of sufficient size so weighted as to come into action with a pressure of eight-tenths of an inch of water, and maintain that pressure constantly at its outlet. All the more important burners in a house ought to be provided with two taps, of which one may conveniently form part of the burner, and have no projecting handle, as has been well arranged in the Silber Argand; the other is part of the gas-fittting to which the burner is attached. The inner tap is then set, once for all, so as to pass the volume of gas the burner should consume at the pressure at which gas is there supplied; for the pressure will vary in different rooms, according to their level and distance from the meter. The ordinary tap is used for turning the gas, on, or down, or off, the adjustment remaining intact. In a small house this plan answers well, and seems preferable to the use of governor-burners; but where many lights are on the same service, of which some are extinguished while others remain burning, the fluctuation of pressure thus caused may probably turn the scale in favour of governor-burners. The little governors or regulators made for this purpose are of two types, both depending on the same principle. In both, a movable diaphragm, pierced with a small hole, is raised by the gas as soon as the difference of pressure, beneath and above, exceeds the weight of the diaphragm. Thus, gas passes through the small hole under a constant pressure, which is proportional to the weight of the diaphragm and inversely proportional to its area. In one type of regulator this pressure is kept constant by the diaphragm when it rises checking the admission of gas into the lower part of the chamber in which it moves; in the other type, some of which are known as "rheometers," this pressure is kept constant by the diaphragm when it rises checking the escape of gas from the upper part of the chamber in which it moves. For ordinary use, these governors should be made accessible and adjustable, though they may remain in use for a long time without the little hole or tube which regulates the passage of gas being appreciably obstructed by any deposit.

In passing now to the improvements which have been made recently in public lighting, the first question which arises is one which has been already suggested, namely, whether the display of electric and gas-lighting, now repeated nightly, is likely to have a long run; whether it is such an improvement that local authorities will generally and permanently be willing to pay for it. At any time during the last fifty years it would have been possible to make the streets, after sunset, as bright as they now are; and no doubt the predecessors of Messrs. Sugg and Bray, and of the directors of the metropolitan companies, would have been willing to undertake the task. The great novelty is the desire on the part of the metropolitan ratepayers, and of the public generally, to have the streets so bright. Gas is burnt, as may be seen from the tables in the Appendix, at a slightly greater advantage from the large burners, or clusters of burners, now exhibited, than from the smaller burners in ordinary use; but within a little, the increased consumption and increased cost are proportional to the increased light. Assuming, however, that the demand for more light in the streets than we have had hitherto is likely to be permanent, it remains to consider how it can best be provided. Into the question of the relative merits of gas and of electricity I shall not venture. Whenever it has been proved that the required amount of light can be got more cheaply where it is wanted from the electric arc than from gas flames, it is unlikely that any of the objections which have been expressed to the unsteadiness, blueness, and excessive intensity of this light will have weight enough to prevent its adoption. In London, the electric light is at one special disadvantage; a larger proportion of violet than of red and yellow rays of light are cut off by fogs, whose colour is often distinctly yellow or orange, and through which, for this reason, the sun looks red.

The principal question to be dealt with is the distribution of light. A much smaller amount of light evenly distributed along a street, is far more useful than a larger amount unequally distributed. Not only is the continual contraction and dilation of the pupil tiring to the eye of anyone passing along a street in which patches of bright light alternate with stretches of comparative darkness, but the eye, whose power of accommodation is gradual, exaggerates the actual contrast, and finds the light more dazzling, and the darkness darker, than, but for this alternation, they would seem to be.

In the present experimental stage, those to whom we are indebted for the existing public illumination have preferred to increase the size and number of the burners in the new street-lamps, rather than to multiply the number of columns. But, owing to this, full advantage has not been taken of a quality in which at present gas is superior to electricity, namely, its divisibility. To throw an equal light, as everyone knows, a lamp at twice the distance must be four times as powerful. If, for clusters of three batwings, giving the light of ninety candles, at intervals of thirty yards, there were substituted single batwings, giving the light of thirty candles, at intervals of fifteen yards, a more uniform and useful illumination would be provided at a smaller cost. The saving of gas to the extent of ten cubic feet an hour would amount to about £6 a year, while the increased cost on each additional lamp column would amount, I am informed, to about £1 a year.

The distribution of light depends also, in a less degree, upon the lanterns in which the burners are enclosed. Mr. Bray, Mr. Sugg, and some others, have devoted much labour to the experimental working out of the most suitable construction for such lanterns, and have had some success also in the difficult task of making them ornamental as well as useful.

Table III. contains an extract from the results of testings made by Mr. Hunt, of Birmingham, of the light given by the new burners enclosed in these lanterns, in the open air. The concave form which the top of the lantern naturally assumes tends to concentrate the reflected light near the base of the column; it would seem, therefore, advantageous to place over the top of the flame, excepting a central aperture for the ascent of the heated gases, a flat reflecting surface, which would throw light to a distance. Whether all the light should be thus reflected downwards, from a white metallic surface, or whether a part should be allowed to reach the walls of neighbouring houses, through a roof of more or less transparent glass; and whether it might be well to diminish the light near the base of the column, and to prevent the flames being visible from the street, except at a little distance, by placing a second plate of transparent glass immediately beneath the burners, as in the Argand shades already described, are questions I would only ask.

The burners to which I have hitherto referred, are improvements in some important details upon burners of the same class which preceded them. The burner to which I would refer in conclusion, the regenerative burner of Mr. F. Siemens, is constructed upon a principle not entirely new, but which has not, until now, been so applied as to produce a burner suited for general use and producing a flame of unexampled brilliancy.

In a lecture given by Professor Faraday, in 1843, he describes a burner in which the products of combustion, after passing up an interior glass chimney, were drawn down between it and an outer glass chimney, and conveyed away at a lower level. His object in devising the burner was to get rid of the products of combustion, but he observed that his arrangement increased the light of the lamp. Some years later, Dr. Frankland set up for his own use a burner of similar construction with the object of improving the light. Small variations of air-supply have so great an influence, that it seemed possible the gain might be due to the check caused by the double chimney; but Dr. Frankland tells me that, though his experiments were made long ago, he sees no reason to doubt their correctness. They are as follows:—

Cubic feet gas per hour.	Light with air and gas cold.	Light with air and gas hot.
2·2 ……	——— ……	13·0 candles.
2·6 ……	——— ……	15·5 ,,
3·3 ……	13·0 candles ……	21·7 ,,
7·7 ……	15·5 ,, ……	———

Gain in light with equal consumption of gas………………………… 67 per cent.

Saving of gas with equal light……… 46 ,,

In Mr. F. Siemens's arrangement the products of combustion are drawn downwards through a porcelain cylinder, which the flame surrounds, into the body of a massive brass burner, where a metal partition which conducts heat rapidly separates them from the ascending gas and air. Thence, having given up a part of their heat, they are conducted by a curved pipe from the side of the burner into a chimney, placed above it. The results which I have obtained with this burner give a much higher proportion of light to gas consumed than any other burners have shown; but the results are less high than those which have been obtained by other observers, owing, I am informed, to the burner sent me for testing having been, by accident, one of German make, designed for a different quality of gas. Mr. Keates has obtained from other specimens of this burner 5·5 candles per cubic foot of gas per hour, and from a smaller burner of a different form, consuming only 6·6 cubic feet per hour, the wonderful yield of light represented by 5·8 candles per cubic foot of gas per hour.

APPENDIX.

Table I.—Testings of Burners, Extracted from the Report of the British Association Committee.

Description of Burner.	Rate of burning	Light in candles.	Light per cubic foot per hour.	Ratio of light per cent.
Union-jet, No. 1	1·6	1	0·6	19
,, No. 3	2·5	3·4	1·3	41
,, No. 6	3·8	7·3	1·9	59
Bray's "Regulator" Union-jet, No. 4	5·3	8·5	1·6	50
Bray's "Special" Union-jet, No. 5	5·2	11·8	2·0	72
Bray's "Special" batswing, No. 5	5·3	14·8	2·3	88
Sugg's "Table-top" batswing	6·2	18·6	3	94
Silber's Argand, B	5·7	21	3·7	116
Sugg's Argand, C	4	12·8	3·2	100
,, ,, E	4·9	17·2	3·4	106
,, 100-candle Argand	26	96	3·7	116
Bray's 40-candle "Standard"	18·4	60·8	3·3	103
,, 60-candle ,,	18·3	60·8	3·3	103
,, 80-candle ,,	22·7	74·9	3·3	103

Table II.—Experiments of A. Vernon Harcourt.

I. Number of testing.	II. Description of burner.	III. Light obtained in candles.	IV. Consumption of gas. Cubic feet per hour.	V. Candle value of gas used in testing.	VI. Consumpton of 16-candle gas to yield the same light.	VII. Light given per cubic foot of 16-candle gas.	VIII. Ratio of light per cent.
1	London Argand	16·	4·7	17·	5·	3·2	100·
2	Bray's No. 5 Fishtail	8·9	3·76	16·8	3·95	2·25	70·
3	,, Batswing	11·6	3·62	17·5	3·96	2·92	91·
4	Silber Argand	16·	4·4	,,	4·81	3.32	104·
5	Sugg's K Argand	34·	9·62	,,	10·1	3·37	105·
6	,, 100-candle Argand	100·	27·	16·1	27·2	3·47	108·
7	,, ,, ,,	100·	27·3	16·	27·3	3·51	110·
8	,, ,, ,,	106·	27·6	17·	29·3	3·64	114·
9	,, 5-spray	174·5	55·4	17·2	59·6	2·93	92·
10	,, 3-spray	90·	28·1	16·3	28·6	3·08	96·
11	,, ,,	90·	30·74	16·2	31·1	2.9	91·
12	,, ,,	110·	30·3	,,	30·7	3·03	95·
13	Bray's 3-spray	90·	32·9	,,	33·3	2·71	85.
14	,, ,,	110·	38·1	,,	38·6	2·86	89·
15	Sugg's 2-spray 60-candle	67·9	19·6	16·6	20·3	3·34	104·
16	Do. turned edgeways	63·9	20·0	,,	20·8	3·07	96·
17	Bray's single 80-candle	80·	24·3	16·3	24·8	3·32	104·
18	,, turned edgeways	72·7	26·	18·	29·3	2·5	77·
19	,, single 60-candle	60·	18·5	16·1	18·6	3·23	101·
20	,, ,, 40-candle	60·	17·7	,,	17·8	3·38	106·
21	Siemens's regenerative	106·	23·2	17.	24·65	4·31	135·
22	,, ,,	106·	24·	16·9	25·35	4·18	131·
23	,, (air-chamber closed)	132·9	24·9	17·7	27·55	4·8	150·

Table III.—Experiments of Mr. Charles Hunt, Engineer of the Birmingham Corporation Gas Department, at Birmingham.

No. of Lamp.	Description of Burners.	Description of Lantern.	Consumpion of Gas. cubic ft. per hr.	Illuminating power in candles, tested with 17-candle gas.	Light per cubic foot per hour.	Ratio of light per cent.
3	Bat's-wing	Ordinary street	5	14 each	2·8	79
4	Sugg's 80-candle Argand	Sugg's shadowless	22·8	74·55 ,,	3·26	96
7	Sugg's 100-candle Argand	3 opal top globe, 30-inch diameter	27	101·70 ,,	3·77	88
9	Sugg's 200-candle Argand	1 opal top globe	45·6	180·20 ,,	3·95	116
10	Bray's 200-candle quadruple bat's-wing	Bray's shadowless	44·4	134·40 ,,	3·02	89
11	Bray's 60-candle triple bat's-wing	Bray's shadowless	21·6	63 ,,	2·92	86
14	Mallet's, Paris	Mallet's	43	141·10 ,,	3·28	96

DISCUSSION.

Mr. W. H. Coffin asked if Mr. Harcourt could state how much of the improvement in the regenerative burner was due to the heating of the air, and how much to the heating of the gas, as in the results given the two were put together. In the early days of gas-lighting it was thought that gas was deteriorated by being heated. He might also mention that in America a very efficient Argand burner was made, in which the air supply was diminished along with the gas supply by a single tap, and this arrangement overcame the objection to the Argand burner—that its superiority to the flat flame was only obtained when burning at its maximum rate.

Mr. Wm. Botly said he had never required to have his gas-fittings looked to since he went into his present residence twenty years ago, except in the kitchen service. He always impressed on his servants the necessity of regulating the consumption in the dining and bedrooms by the meter, and he also made it a rule that the gas should be turned off at the meter before it was turned off at the burners. The consequence was that the gas in the pipes was always consumed, the upper lights sometimes burning for twenty minutes after it was turned off at the meter. This kept the pipes clean, and much trouble and inconvenience was prevented.

Mr. G. E. Stevenson (Peterborough) thought all gas-men would agree that Mr. Harcourt had hit the right nail on the head, when he said that improved illumination by gas should be obtained rather by a better distribution of small lights, than the use of very large and powerful burners. It had struck him that in the production of these very large burners there had been rather an inclination to follow the lead set by the promoters of the electric light. Formerly it was always held that the right thing was to use comparatively small lights, and the closer together in public lighting they could get the local authorities to have them placed, the better the illumination. With the introduction of the electric light, however, it had become the fashion to have large and powerful lights; with the electric arc it was impossible to do otherwise; but one of the great objections to these was, that the light was continually striking the eye of the observer. Mr. Harcourt attributed this to the novelty, and said that if the sun were looked at in the same way, still greater inconvenience would be felt; but it must be remembered that the position of a large electric light or gas burner was very different to that of the sun, which, except when near the horizon, was out of ordinary range of direct vision, except by special effort. The electric light, on the other hand, even if placed at the height of 40 feet, like some of Dr. Siemens's in the City, was at a very different angle to anyone not very close to it, and could hardly fail to attract attention. With regard to the comparative advantages of a central light or brackets in a room, he had made a mental calculation, and found there would be no saving in the small lights. Taking, for instance, a room 16 feet square, it was considered by gas-men that the proper proportion of light for ordinary purposes was one candle, observed at a distance of one foot; if that had to be attained at the walls of such a room, the central light would have to equal 64 candles, which, giving a light of 3·4 candles per cubic foot, would burn 20 cubic feet per hour. If the same room were lit by four Argand burners affixed to the walls, of 16 candles each, there would be exactly the same combustion; and the minimum of light would be in the centre, where there would be the light of one candle. At the sides, however, there would be much more light, where probably it would be more required; so that even if there were no saving, there would be more even distribution. But when you came to the illumination of streets and public places, there would probably be a great saving by more distribution. He was rather surprised to hear Mr. Harcourt say that there would be a greater advantage in increasing the intensity of any light than in increasing the volume; and though he quite accepted his statement, it was obvious that if there were an advantage economically, there would be a disadvantage in the effect on the optic nerves; and it was noticed that the brilliant electric arc lights did not carry to such a distance as the feeble gas-lights of larger volume; especially in the case of fog or smoke. With regard to the recommendation of a second tap on the Argand burner, as adopted by Silber, it was generally understood that when gas was throttled in that way, it did not give the same illuminating power that it did when the pressure was regulated through a governor. He was acquainted with some of the cheap Argand burners made in America, having a kiud of switch handle at the bottom, which reduced the supply of gas and air at the same time; and though this of itself must be an advantage, he must say that on testing them against Sugg's Argand burner, he found them far inferior in illuminating power.

Mr. F. Hartley said Mr. Harcourt had put forward such sound views, that almost all practical men must agree with him, and consequently discussion was almost rendered impossible. He had been much struck with the table showing the results of Faraday's gas-burner, and he thought all gas-men would be astonished to see that the consumption of 3·23 feet of gas gave a light of 13 candles, when the gas was cold. He might explain, however, that the gas used by Dr. Frankland was the cannel gas of the Western Gas Company, which, at that time, had an illuminating power of about 24 candles. Unfortunately, he (and he believed Mr. Sugg also) had hitherto failed to construct a burner which would yield similar results; but he should make further attempts, after what he had heard that night. He could not but congratulate not only the gas world, but also the public, on the immense improvement in burners which was shown by the tables. He had been testing burners for a great many years, and knew that, within the last eight or ten years especially, enormous strides had been made; and on looking at the results produced by the Siemens burner, they could not but anticipate that still further advances would be made. At the present time, there was a manufactory near Paris where oxygen was being produced somewhat cheaply; and some experiments had recently been made by a German scientific man in the application of oxygen to ordinary gas, the result being that, when a limited quantity was introduced, a considerable increase of intensity in the light was effected. He must differ somewhat from Mr. Stevenson, for he believed that improvement in the future would lie rather in the increase of intensity than of quantity; and that they might obtain such a degree of brightness as would enable gas to hold its position as against the electric light better than it did now. With regard to large gas burners, it seemed to him that the manufacturers had had no option, seeing that the lamp-posts were so sparsely placed. They were arranged from 70 to 150 yards in the suburbs, and, therefore, when the lighting of a district had to be increased, the only thing possible was to produce burners of high power. When the parishes resolved to put up more posts, and employ lights of moderate power, he was quite prepared to believe that the streets would be more efficiently and pleasantly lit than they were with these very large burners, except in large central spaces.

Mr. W. LASCELLES SCOTT asked if Mr. Harcourt had given any consideration to the question of lighting the public streets with large burners, and distributing the light by means of lenses. With regard to Dr. Frankland's arrangement for increasing the illuminating power of gas by the heating of the gas and air—though no doubt a great portion of the effect was due to the actual rise of temperature, and to the heating of the solid particles of the flame—he thought the absolute increase of pressure evolved under these circumstances might have rather more to do with the increase of illuminating power. One point had not been touched upon, with regard to which he had made some experiments, viz., the introduction of solid substances into the flame, which became incandescent, and so converted some of the heat of the flame into light. He had arranged an ordinary fishtail burner at an angle of from 60° to 45°, and allowed finely divided alkaline earths to percolate through the flame; and he found that without any increased consumption of gas, a fairly marked increase of light resulted. The mean results of several experiments were as follows:—With a normal flame of 16·71 candles, the addition of pure lime gave 17·95, of magnesia 17·13, and, curiously enough, of an intimate mixture of lime and magnesia, a larger increase than either separately, viz., 18·23. The same mixture, with the addition of ten per cent. of another earth gave 18·34. With a specially constructed Argand burner, the flame being conical, the light was raised from 62·4 candles, burning gas alone, to 67·3 with the addition of lime only, and with lime and magnesia to 68·5.

Mr. CHARLES E. BOTLEY could not quite agree that it was desirable to split up the light into a number of small flames, for he had found that, in the lighting of railway stations, to which he had given some attention lately, not only did you get increased brilliancy, but an actual saving in gas, by having large flame lanterns; that, in fact, by combining the gas lights you got 150 per cent. more light with a reduced cost of gas. In the usual style of lamps at railway stations, the construction was very defective, the opening at the bottom being very large, and very little ventilation being provided at the top. He was rather surprised to hear Mr. Harcourt speak against chandeliers, because great strides had been made lately in improving their appearance, and generally speaking, he thought a better effect was produced by a central chandelier than by brackets. Another matter in connection with concentrated lights was the saving in repairs. He found that the cost of maintaining these large lamps was about the same as the small ones, there being very little wear and tear, and, therefore, there would be a great saving in having a few large lamps instead of a large number of small ones.

Mr. QUINLAN said Mr. Harcourt had given the palm to Argand burners, but they were not suitable for use in workshops and warehousus, and he should like to know if he had made any experiments with regard to the best form of flat-flame burners. Not long since, he (Mr. Quinlan) had some duplicate burners sent him, which had been examined by a very competent authority, who reported that the light given was half as much again as that given by the burner of one of the makers who had been mentioned that evening.

Mr. GEORGE LIVESEY said he had been much pleased with the remark made by Mr. Harcourt, as to the heating effects of gas. Many people objected to gas on account of the heat, but, as had been pointed out, there were very few evenings when that would really be an objection. He did not know what to think about the very large burners which had been shown. Mr. Siemens's was, no doubt, very beautiful, but he feared it might be found rather too complicated for ordinary use. At any rate, it showed what could be got out of gas, and he thought they were all indebted to the electric light people for giving a stimulus to inventors.

Mr. LIGGINS said it was now forty years since he had the pleasure of hearing Professor Faraday describe the burner which had been mentioned, and he then recommended his brother, who was a chandelier-maker in Wardour-street, as the maker of this burner. At the present time he only knew of two rooms in England where it was used; one was the dining-room of a friend of his in Kensington, which was one of the most charmingly-lighted rooms he knew of, without any objectionable heat or deterioration of the atmosphere; and the other was the room for which it was originally designed, the library of the Athenæum Club.* It was found that the gas rotted the bindings of the books, and Professor Faraday being a member of the club, turned his mind to remedying the evil, and he did so with great success. Anyone who wished to have their dining-rooms lit with perfect satisfaction at a minimum cost could not do better than adopt the Faraday light. He did not think bracket lights at all suitable for a dining-room, as they would throw shadows on the table, which would be inconvenient. He must take exception to the remark that public bodies were not sufficiently ready to try new improvements. In Kensington he found it was the outside public who were always urging on their representatives to try experiments, and the difficulty was to hold back until something was discovered which it was really worth going to expense about. Kensington, he believed, was as far advanced in public lighting as any place. Some years ago, the authorities adopted the average meter system, by which they saved about £1 per lamp, and there were, he believed, about 2,000 lamps. The quality of the burners had been improved, and the further improvement, to which allusion had been made, of putting a reflector over the light, had also been adopted, though he was not certain that the angle was such as to diffuse the light to the greatest distance. He thought it was a great misfortune that there was not a central authority to investigate all these new inventions, and therefore they were all the more indebted to Mr. Harcourt for the admirable paper he had read them on recent improvements in gas-lighting. He believed they would have been very much at a standstill if it had not been for the stimulus of the electric light.

Mr. MC.DOUGALL suggested that a light in the centre of a room was more evenly diffused, and more completely used, than if it were distributed in brackets, where a great part would be absorbed by the walls.

Mr. VERNON HARCOURT, in reply, said he did not think it was possible to distinguish in the case of the Siemens burner whether the good result obtained was due to the heating of the air or the gas; he should suppose that since the two must come into close contact before any chemical change took place between them, it could not matter which of the two had previously been raised to a high temperature, excepting for this reason, that the mass of air and consequently total quantity of heat which it would absorb, was much larger than that of the gas. Roughly speaking, gas required a little more than its own volume of oxygen, and, therefore, rather more than five times its own volume of air for combustion, and in a common burner considerably more must be taken; therefore, it was more important to heat the air than the gas. It was obviously the case that we had not the same temptation to look at the sun, apart from its being so familiar, as at an electric light, and yet it would sometimes happen, as it did to himself when he first saw the electric light used for illumination in the roof of the Albert-hall, that one looked at it unnecessarily, and did not do justice to its illuminating properties. He did not agree with Mr. Stevenson that the tap in the Silber burner interfered with the development of the light. The case in which it did so was when an ordinary tap was put too near the burner, where, no doubt, the gas being checked, caused a ripple in the current, and the character of the flame was impaired. But in the case referred to, the tap was more in the nature of a regulator, and the gas was equally distributed before it reached the outlet of the burner. He could not say what might be done in the way of using large lamps with lenses. It might be a better plan—but it was much less easy and simple, and he was not sure that it would be found so effectual or economical. He had not tried any experiments on the amount of light developed by shaking powders through a gas-light, and he thought there would be great difficulty in carrying this suggestion out into a practical form. He had tried one of the duplex burners, and got very good results, but it was rather difficult to say to what the improvement in the light was really due. There were two causes which might contribute to it. One was the heating of each burner by its neighbour; but on the other hand, a more solid flame was produced, and thus there was a relatively smaller surface exposed to the air. With regard to gas pendants, he ought not perhaps to have entered into the question, which was rather one of taste. He was far from intending to deny that artistically good pendants had been devised, and he had expressly excepted dining rooms, where certainly a central light was wanted—not one behind those sitting at table. He did not intend his suggestion as a means of gaining light, but only that by a better distribution of it, all parts of the room would be rendered more habitable, so to say. The ordinary arrangement contributed to what was apt to happen in the colder part of the year, in which the centre of the room, in front of the fireplace, was the one to which all resorted, and the outlying portions of the room were, at any rate, after dark, less attractive. The more general use of the room would, he thought, be promoted by the system he had suggested.

The CHAIRMAN, in proposing a cordial vote of thanks to Mr. Harcourt, said the many subjects he had brought forward were all interesting, and were the results of practical examination on his part; and in these, as in many other points, he had contributed very largely to the general knowledge on the subject of improvements in gas illumination. He had not observed that any great stress had been laid in the discussion on one of the points mentioned, to which he confessed he attached considerable importance, and that was the mixture of the air and the gas. He had no doubt that, as had been shown in the case of the Argand burners, particularly great improvement had been effected in this way. As regards the general improvment in gas burning, he was glad to hear it stated that improvements which dated from the introduction of the electric light, were those only which had reference to large masses of light. Whether or not those massive burners were most desirable was one point, and whether they were most attractive was another; but he feared there would still be a desire for display in particular localities, and that, as a consequence, these large burners would still have to be made in order to supply the popular demand. His own opinion was, certainly, in the other direction. He preferred to have a street uniformly illuminated throughout by lights of a moderate size, but he could not shut his eyes to the fact that the popular demand was in the other direction. As to the electric light, some preferred it, and some preferred gas, but the question really resolved itself into one of price. When once it could be proved that the electric light was, light for light, cheaper than gas, all objections would disappear. It was mainly a question of price, and so long as the price at which illumination could be effected by means of gas, especially for out-door purposes and public buildings, was less than that required for electricity, it would hold its own. If people wanted larger lights they could have them, and they could have had them before if they would only pay for them. The old gas-burners were, from time to time, improved, before the introduction of the electric light, and even the worst of the burners now in use, was a great improvement on the earlier forms, so that, in fact, when added to the enormous advantages resulting from heating the gas and air, there must be really almost a cent. per cent. improvement on the illuminating power of gases it was some twenty-five years ago. The remark made by one speaker as to the deteriorating effect of heating gas arose from a confusion of two different things. If you heated gas pretty strongly, then allowed it to cool, and then burned it, there was no doubt a deterioration; but even that did not happen if it were only heated moderately; and however highly you heated it, if it were burned directly, there was, on the whole, an increase of the illuminating power. It seemed obvious that if the means employed for reducing the amount of gas consumed in an Argand burner could also effect a reduction in the amount of air brought into contact with the flame, it would be a very desirable thing to effect at one operation by means of a single tap; and whether or not the American burners referred to were well or ill made, gas-burner manufacturers would do well to turn their attention in that direction.

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* The library at the Athenæum has, for many years, been lighted by a sun-burner.—ED.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

SILK-PRODUCING BOMBYCES AND OTHER LEPIDOPTERA REARED IN 1881.

By Alfred Wailly.

(Membre-Lauréat de la Société d'Acclimatation de France.

By referring to my reports for the years 1879 and 1880, which appeared in the *Journal of the Society of Arts*, February 13th, and March 5th, 1880, February 25th, and March 4th, 1881, it will be seen that the bad weather prevented the successful rearing in the open air of most species of silk-producing larvæ. In 1881, the weather was extremely favourable up to the end of July, but the incessant and heavy rains of the month of August, and beginning of September, proved fatal to most of the larvæ when they were in their last stages. However, in spite of my many difficulties, I had the satisfaction of seeing them to their last stage. Larvæ of all the silk-producing Bombyces were preserved in their different stages, and can be seen in the Bethnal-green Museum. In July, when the weather was magnificent, the little trees in my garden were literally covered with larvæ of more species than I ever had before, and two or three more weeks of fair weather would have given me a good crop of cocoons, instead of which I only obtained a very small number. The sparrows, as usual, also destroyed a quantity of worms, in spite of wire or fish-netting placed over some of the trees.

On the trees were to be seen—*Attacus cynthia* (the Ailanthus silkworm), the rearing of which was, as usual, most successful; *Samia cecropia*, and *Samia Gloveri*, from America; also hybrids of *Gloveri-cecropia* and *Cecropia-Gloveri; Samia promethea* and *Telea polyphemus; Attacus pernyi*, and a new hybrid, which I obtained this last season by the crossing of *Pernyi* with *Roylei*. For the first time I reared *Actias selene*, from India, on a nut tree in the garden, and *Attacus atlas*, on the ailanthus. The *Selene* larvæ reached their 5th and last stage. The *Atlas* larvæ only reached the 3rd stage, and were destroyed by the heavy rains; only two remained on the tree till about the 8th or 9th of September, when they had to be removed. I shall now reproduce the notes I took on some of the various species I reared.

Actias Selene.—With 60 cocoons I only obtained one pairing. The moths emerged from the beginning of March till the 13th of August, at intervals of some duration, or in batches of males or females. I obtained a pairing of *Selene* on the 30th of June, 1881, and the worms commenced to hatch on the 13th of July. The larvæ in first stage are of a fine brown-red, with a broad black band in the middle of the body. The second stage commenced on the 20th of July, larvæ of a lighter reddish colour, without the black band; tubercles black. Third stage commenced on the 28th of July; larvæ green; the first four tubercles yellow, with a black ring at the base; other tubercles, orange-yellow. Fourth stage commenced on the 6th of August; larvæ green; first four tubercles golden-yellow, the others orange-red. Fifth stage commenced on the 19th of August; first four tubercles yellow with a black ring at the base; other tubercles yellow, slightly tinged with orange-red; lateral band brown and greenish-yellow; head and forelegs dark brown. As stated before, the larvæ were reared on a nut-tree in the garden, till the last stage. *Selene* feeds on various trees—walnut, wild cherry, wild pear, &c. In Ceylon (at Kandy), it is found on the wild olive-tree. As far as I am informed by correspondents in Ceylon, this species is not found—or is seldom found—on the coasts, but *Attacus atlas* and *Mylitta* are commonly found there.

Altacus (antheræa) Roylei (with 60 cocoons); three pairings only were obtained, and this species I found the most difficult to pair in captivity. Two moths emerged on the 5th of March, a male and a female, and a pairing was obtained; but the weather being then too cold, the ova were not fertile, the female moth, after laying about 200 eggs, lived till the 22nd of March, which is a very long time; this was owing to the low temperature. The moths emerged afterwards from the 8th of April till the 25th of June. A pairing took place on the 2nd of June, and another on the 6th of June.

Roylei (the Himalaya oak silkworm), is very closely allied to *Pernyi*, the Chinese oak silkworm, the *Roylei* moths are of a lighter colour, but the larvæ of both species can hardly be distinguished from one another. The principal difference between the two species is in the cocoon. The *Roylei* cocoon is within a very large and tough envelope, whilst that of *Pernyi* has no outer envelope at all. The larvæ of *Roylei* I reared did not thrive, and the small number I had only went to the 4th stage, owing to several causes. I bred them under glass, in a green-house. A certain number of the larvæ were unable to cut the shell of the egg.

Here are a few notes I find in my book :—Ova of *Roylei* commenced to hatch on the 29th of June; second stage commenced on the 9th of July. The larvæ in the first two stages seemed to me similar to those of *Pernyi*, as far as I could see. In second stage, the tubercules were of a brilliant orange-red; on anal segment, blue dot on each side. Third stage, four rows of orange-yellow tubercles, two blue dots on anal segment, brilliant gold metallic spots at the base of the tubercles on the back, and silver metallic spots at the base of the tubercles on the sides. No further notes taken.

One of my correspondents in Vienna (Austria) obtained a remarkable success in the rearing of *Roylei*. From the 25 eggs he had 23 larvæ hatched, which produced 23 fine cocoons. The same correspondent, with 35 eggs of *Samia Gloveri*, obtained 20 cocoons. My other correspondents did not obtain any success in rearing these two species, as far as I know.

Hybrid Roylei-Pernyi.—I have said that it is extremely difficult to obtain the pairing of *Roylei* moths in captivity. But the male *Pernyi* paired readily with the female *Roylei.* I obtained six such pairings, and a large quantity of fertile ova. The pairings of *Roylei* (female) with *Pernyi* (male) took place as follows: two on the 21st of May, one on the 3rd of June, two on the 4th of June, and one on the 6th.

The larvæ of this new hybrid, *Roylei-Pernyi*, contrary to what might have been expected, were much easier to rear than those of *Roylei*, and the cocoons obtained are far superior to those of *Roylei*, in size, weight, and richness of silk. The cocoon of my new hybrid has, like *Roylei*, an envelope, but there is no space between this envelope and the true cocoon inside. Therefore, this time, the crossing of two different species (but, it must be added, two very closely allied species) has produced a hybrid very superior, at least to one of the types, that of *Roylei*. The cocoons of the hybrid *Roylei-Pernyi* seem to me larger and heavier than any *Pernyi* cocoons I have as yet seen.

The larvæ of this new hybrid have been successfully reared in France, in Germany, in Austria, and in the United States of North America. The cocoons obtained by Herr L. Huessman, one of my German correspondents, are remarkable for their size and beauty. The silk is silvery white.

I have 17 cocoons of this hybrid species, which number may be sufficient for its reproduction. But the question arises, "Will the moths obtained from these cocoons be susceptible of reproduction ?

In my report on Lepidoptera for the year 1879, I stated, with respect to hybrids and degeneracy, that hybrids had been obtained by the crossing of *Attacus Pernyi* and *Attacus Yama-Maï*, but that, although the moths (some of which may be seen in the Bethnal-green Museum), are large and apparently perfect in every respect, yet these hybrids could not be reproduced. It must be stated that these two species differ essentially in one particular point. *Yama-Maï* hybernates in the *ovum* state, whilst *Pernyi* hybernates in the *pupa* state. The hybrids hybernated in the *pupa* state. *Roylei*, as *Pernyi*, hybernates in the *pupa* state.

In the November number, 1881, of "The Entomologist," Mr. W. F. Kirby, of the British Museum, wrote an article having for its title :—"*Hermaphrodite-hybrid Sphingidæ*," in which, referring to hybrids of *Smerinthus ocellatus* and *populi*, he says that hermaphroditism is the usual character of such hybrids.

I extract the following passage from his article :—"I was under the impression that hermaphroditism was the usual character of these hybrids; and it has suggested itself to my mind as a possibility, which I have not, at present, sufficient data either to prove or to disprove, that the sterility of hybrids in general (still a somewhat obscure subject) may perhaps be partly due to hybridism having a tendency to produce hermaphroditism."

Now, will the moths of my new hybrid *Roylei-Pernyi* (which I expect will emerge in May or June, 1882), have the same tendency to hermaphroditism as has been observed with the hybrids obtained by the crossing of *Smerinthus populi* with *Sm. ocellatus?* I do not think that such will be the case with the moths of the hybrid *Roylei-Pernyi*, on account of the close relationship of *Roylei* with *Pernyi*, but nothing certain can be known till the moths have emerged. Here are the few notes taken on the hybrid *Roylei-Pernyi.* Ova commenced to hatch on the 12th of June; these were from the pairing which had taken place on the 21st of May. Larvæ, black with long white hairs. Second stage commenced on the 21st of June. Larva, of a beautiful green; turbercles orange-yellow; head dark brown. Third stage commenced on the 1st of July; 4th stage on the 7th. Larva of same colour in those stages; tubercles on the back, violet-blue or mauve; tubercles on the sides, blue Fifth stage commenced on the 18th of July. Larva, with tubercles on back and sides, blue or violet-blue. First cocoon commenced on the 10th of August. Want of time prevented me from taking fuller and more accurate notes.

Attacus Atlas.—For the first time, as stated before, I attempted the rearing of a small number of *Atlas* larvæ in the open air on the Ailanthus tree, but had to remove the last two remaining larvæ in September; the others had all disappeared in consequence of the heavy and incessant rains. These larvæ were from eggs sent to me by one of my German correspondents. The pairing of the moths had taken place on the 17th of July, and the eggs had commenced to hatch on the 4th of August.

I had about 80 cocoons of another and larger race of *Atlas* imported from the Province of Kumaon, but only eight moths emerged at intervals from the 31st of July to the 30th of September. Not only did the moths emerge too late in the season, but there never was a chance of obtaining a pairing. In my report on Indian silkworms, published in the Nov. number of the *Bulletin de la Société d'Acclimatation*, for the year 1881, compiled from the work of Mr. J. Geoghegan, I reproduce the first appendix of Captain Thomas Hutton, to Mr. Geoghegan's work, in which are given the names of all the Indian silkworms known by him up to the year 1871.

Of *Attacus atlas*, Captain Hutton says:—"It is common at 5,500 feet at Mussoorie, and in the Dehra Doon; it is also found in some of the deep warm glens of the outer hills. It is also common at Almorah, where the larva feeds almost exclusively upon the 'Kilmorah' bush or *Berberis Asiatica;* while at Mussoorie it will not touch that plant, but feeds exclusively upon the large milky leaves of *Falconeria insignis.* The worm is, perhaps, more easily reared than any other of the wild Bombycidæ."

I will now quote from letters received from one of my correspondents in Ceylon, a gentleman of great experience and knowledge in sericiculture.

In a letter, dated 24th August, 1881, my correspondent says:—"The *Atlas* moth seems to be a near relation of the *Cynthia*, and would probably feed on the Ailanthus. Here it feeds on the cinnamon and a great number of other trees of widely different species; but the tree on which I have kept it most successfully in a domestic state is the *Milnea Roxburghiana*, a handsome tree, with dark-green ternate leaves, which keep fresh long after being detached from the tree. I do not think the cocoon can ever be reeled, as the thread usually breaks when it comes to the open end. I have tried to reel a great many *Atlas* cocoons, but always found the process too tedious and troublesome for practical use.

"The *Mylitta* (Tusser) is a more hardy species than the *Atlas*, and I have had no difficulty in domesticating it. Here it feeds on the cashew-nut tree, on the so-called almond of this country (*Terminalia catappa*), which is a large tree entirely different from the European almond, and on many other trees. Most of the trees whose leaves turn red when about to fall seem to suit it, but it is not confined to these. In the case of the *Atlas* moth, I discovered one thing which may be well worth knowing, and that was, that with cocoons brought to the seaside after the larvæ had been reared in the Central Provinces, in a temperature ten or twelve degrees colder, the moths emerged in from ten to twenty days after the formation of the cocoon. The duration of the *pupa* stage in this, and probably in other species, therefore, depends upon the temperature in which the larvæ have lived, as well as the degree of heat in which the cocoons are kept; and in transporting cocoons from India to Europe, I think it will be found that the moths are less liable to be prematurely forced out by the heat of the Red Sea when the larvæ have been reared in a warm climate than when they have been reared in a cold one.

"I do not agree with the opinion expressed in one of your reports, that the short duration of the larva stage, caused by a high temperature, has the effect of diminishing the size of the cocoons, because the *Atlas* and *Tusser* cocoons produced at the sea-level here are quite as large as those found in the Central Provinces at elevations of 3,000 feet or more. According to the treatise on the "Silk Manufacture," in "Lardner's Cyclopædia," the Chinese are of opinon that one drachm of mulberry silkworms' eggs will produce 25 ounces of silk if the caterpillars attain maturity within 25 days; 20 ounces if the commencement of the cocoons be delayed until the 28th day; and only 10 ounces if it be delayed until between the 30th and 40th day. If this is correct, a short-lived larva stage must, instead of causing small cocoons, produce just the contrary effect."

In another letter, dated Nov. 25th, 1881, my correspondent says:—"I am sorry that you have not had better success in the rearing of your larvæ, but you should not despair. It is possible that the choice of an improper food-plant may have as much to do with failures as the coldness and dampness of the English climate. I lost many thousands of *Atlas* caterpillars before I found out the proper tree to keep them on in a domesticated state; and when I did attain partial success, I could not keep them for more than one generation, till I found the *Milnea Roxburghiana* to be their proper food plant. I do not know the proper food-plant of the *Mylitta (Tusser)*, but I have succeeded very well with it, as it is a more hardy species than the *Atlas*. Though a *Bombyx* be polyphagous in a state of nature, yet I think most species have a tree proper to themselves, on which they are more at home than on any other plant. I should like, if you could find out from some of your correspondents in India, on what species of tree *Mylitta* cocoons are found in the largest nnmbers, and what is about the greatest number found on a single tree. The *Mylitta* is common enough here, but there does not seem to be any kind of tree here on which the cocoons are to be found in greater numbers than twos and threes; and there must be some tree in India on which the cocoon. are to be found in much greater plenty, because they could not otherwise be collected in sufficient quantity for manufacturing purposes. The *Atlas* is here found on twenty or more different kinds of trees, but a hundred or a hundred and fifty cocoons or larvæ may be found on a single tree of *Milnea Roxburghiana*, while they are to be found only singly, or in twos and threes, on any other tree that I know of. The *Atlas* and *Mylitta* seem to be respectively the Indian relations of the *Cynthia* and *Pernyi*. It is, therefore, probable that the Ailanthus would be the most suitable European tree for the *Atlas*, and the oak for the *Mylitta*."

Attacus Mylitta (Antheræa paphia).—I did not reeeive a single cocoon of this species for the season 1881. My stock consisted of seven cocoons, from the lot received from Calcutta at the end of February, 1880. Five were female, and two male cocoons; one of the latter died, thus reducing the number to six. The moths emerged as follows:—One female on the 21st of June, one female on the 26th, one female on the 28th, one female on the 1st of July, and one male on the 3rd of August; the latter emerging 34 days too late to be of any use for rearing purposes. The last female moth emerged, I think, about the end of September. These cocoons had hybernated twice, as has been the case with other Indian species I had Indian cocoons which hybernated even three times.

NEW CINCHONAS.

Notwithstanding the rapidity with which new species and varieties of *Cinchona* have been introduced and acclimatised in various parts of the world, new kinds are still continually being brought to notice. It is not so long since the form known as *C. Ledgeriana* was attracting considerable attention, some of which, however, has since been directed to *C. Cuprea*. More recently still, some very valuable kinds have come to notice in the City. These are the "Calisaya morada veluta" (*Cinchona calisaya Boliviana subvar pubescens*), and the "Calisaya verde" (*C. Calisaya oblongifolia*), and the "Calisaya fina" (*C. Calisaya var vera*). Of the Calisaya verde, Markham says he was told by the people that this tree was a very large one, wholly devoid of any red colour on the leaves, and habitually growing very far down the valleys, and even in the plains. From 600 lbs. to 700 lbs. of bark, it is said, is usually furnished by a tree of this kind, while the Calisaya fina yields only from 300 lbs. to 400 lbs. From a report, or letter, on these barks, by Mr. E. M. Holmes, of the Pharmaceutical Society, it would seem that the Calisaya verde is the most profitable plant for cultivation, which, indeed, is stated to be the case in a letter from Bolivia, which accompanied the consignment of seeds. On this head, Mr. Holmes says, "that although the Calisaya verde yields only 6½ to 9 per cent. of pure sulphate of quinine (while the very best *Ledgeriana* yields 13 per cent., and other specimens not more than 6 per cent.), yet as the Calisaya verde yields twice the amount of bark that the fina or *Ledgeriana* does, this is equivalent to from 13 to 18 per cent. of quinine in the calisaya verde. Moreover, from the fact that the Calisaya verde is a more vigorous tree than the delicate *Ledgeriana*, and will grow at a lower elevation, it is obvious that it can be cultivated to a much greater extent, and may be extremely valuable for grafting the *Ledgeriana* upon, more especially since the attempt to graft the Ledgeriana upon *C. Succirubra* has proved unsuccessful. It may be worth while to state that the seeds of these valuable kinds are to be obtained of Messrs. Christy and Co., 155, Fenchurch-street.

WATER POWER IN THE PUNJAB.

The following particulars respecting the means proposed to be adopted by the Government of the Punjab, for the purpose of making the water-power of the Punjab canals available, taken from the *Gazette of India*, have been communicated by the India Office.

Up to the present time, two contracts only have been entered into for the use of water-power by large companies; but Sir Robert Egerton is of opinion that, when the advantages offered by the Punjab canals are better known, they will be sure to attract the attention of persons interested in promoting manufacturing industries.

Raw material in the shape of cotton, wool, hides, hemp, &c., are to be found in abundance in the Punjab; there is also a population sufficient to supply the labour required for factory operations; but the scarcity and dearness of fuel is such that it is almost impossible to make a manufactory remunerative in any case where steam-power is necessary for its working. Wood costs about Rs. 30 per 100 maunds, coal about Rs. 1.8 per maund at Amritsar, and 14 annas a maund at Delhi, so that the cost of working a 100-h.p. steam-engine would be about Rs. 150 per diem, while a water-wheel of similar power would cost only about Rs. 5 per diem.

For this reason the Lieutenant-Governor again notifies the localities where this vast water-power is available, aod the conditions under which it will be leased. On the Bári Doáb canal, there are 26 sites at which water-power in excess of 200-h.p. is available. A metalled road passes at a short distance from them, and a railway is about to be constructed from Amritsar to Pathánkot, which will pass within a few miles of all of these sites. On the Western Jumna canal, there are four sites at which there is water-power in excess of 200-h.p., and eight other sites where from 100 to 200-h.p. is available. The Grand Trunk-road is at no great distance from any of these sites. The Government are prepared to grant the use of the water for working machinery for periods not exceeding 20 years on the terms shown below:—

Approximate rates per horse-power per annum.

For the 1st 3 years	*Nil.*
„ 2nd 5 „	Rs. 60
„ 3rd 6 „	„ 100
„ 4th 6 „	„ 150

Bári Doáb Canal.—In the first 15 miles from the head of this canal there are 19 falls, varying from 4·5 to 9·5 feet in height, where the minimum supply of water is 1,500 cubit feet per second. They are so close together, that there would be little difficulty in joining two or even more of them by a channel for the supply of the mill, if it were proposed to use machinery requiring a greater fall than is available at any one site. This has already been done for the "Punjab Sugar Works Company, Limited," which has been established at Sujánpur between the 5th and 6th falls. There is a flour mill at the 7th fall of four pairs of stones, worked by native machinery.

The whole of the falls are situated in the district of Gurdaspur, the population of which is about 488 to the square mile; the number of agriculturists being 371,581, and non-agriculturists 283,781.

The principal crops grown in this district are—

	Acres.
Rice, about	76,000
Wheat, about	280,000
Other food-grains, about	155,000
Pulses, about	115,000
Drugs and spice, about	15,000
Oil seeds, about	22,000
Fibres, about	26,000
Sugar-cane, about	43,000

The rates of labour are as follow:—

Skilled—4 annas to 8 annas per diem.
Unskilled—2 annas to 3 annas per diem.

Western Jumna Canal.—The first fall available on this canal is at the crossing of the Grand Trunk-road from Umballah to Delhi, about two miles from Karnál. The second is about one mile, the third two miles, and the fourth five miles from the metalled road, the communication being by the unmetalled road along the canal bank. At each of these sites there is more than 500-h.p. available.

The falls are situated in the Karnál and Delhi districts, of which the population is 259 and 490 per square mile respectively. The numbers of agriculturists and non-agriculturists being as follows:—

	Delhi.		Karnál.
Agriculturists	277,491	..	305,974
Non-agriculturists ..	344,184	..	302,968

The principal crops grown in these districts are:—

	Delhi. Acres.		Karnàl. Acres.
Rice	12,000	..	96,000
Wheat	116,000	..	101,000
Other food grains ..	256,000	..	286,000
Pulses	71,000	..	97,000
Drugs	7,500	..	1,300
Oil-seeds	9,000	..	5,000
Fibres	17,000	..	22,000
Dyes	700	..	200
Sugar-cane	32,000	..	16,000

The rates of labour per day are as follows:—

	Delhi. Annas.		Karnál. Annas.
Skilled	5 to 6	..	4 to 8
Unskilled	2 to 3	..	1½ to 3

Correspondence.

TECHNICAL SCHOOLS.

In the *Journal* of 3rd inst., page 420, last line but four, "Whitney Schools" should be Whittling School; belonging to the Industrial Education Society of Boston, U.S. A report thereon, illustrating some methods to be pursued in industrial education—as far as the manual element is concerned, for wood-work and for ironwork—occurs in the Forty-First Annual Report of the Board of Education, Massachussetts, 1876-7, pp. 185-219. Plans and photographs of forgings accompany; also full notes on the system of inspection pursued. An account of the Practical Technological Institute of St. Petersburg, and of the Imperial Technical School of Moscow, with the programmes of instruction in the mechanical arts, as introduced into the workshops of the school, occurs in the general report of the judges, Group xxviii, pp. 161-179, issued by the U.S. Centennial Commission of the International Exhibition, 1876. It concludes with these words:—"What Russia has done for technical education at the Philadelphia Exhibition, no man may now estimate.

It is certain that the service was very great, and has earned for her the gratitude of all who are at work upon its problems, whether in the Old or the New World."

JOHN YEATS.

Chepstow, 6th March, 1882.

Notes on Books.

L'ART ANCIEN A L'EXPOSITION NATIONALE BELGE, PUBLIE SOUS LA DIRECTION DE CAMILLE DE RODDAZ. (Bruxelles: Rozez. Paris: Firmin Didot and Cie. 1882.) Imp. 8vo.

This fully illustrated volume contains an account of such of the most important contributions to the National Belgian Exhibition as would help to form a general history of ancient art. The subject has been divided under the following headings, each of which has been undertaken by a special author. Gold and silver work and enamels; brass ware; medals of ancient Belgian provinces; armoury; iron-work; chests and clocks; historical tapestry; furniture; ivories; manuscripts; musical instruments; lace; fans; glass; and ceramic ware. The editor completes the work with a notice of the Italian art exhibited in the Salon L. Somzée. The volume is intended not only as a record of an important national Exhibition, but also as a work which shall be of value to the artist and the antiquary, presenting them with illustrations of some of the finest specimens of art, lent by famous collectors.

General Notes.

EXPLOSIONS IN FLOUR MILLS.—A Parliamentary paper just issued contains a report by Mr. Thomas J. Richards, of the Board of Trade, to the Home Secretary, respecting an explosion which took place on September 14th, at the corn-mill of Messrs. Fitton and Son, at Macclesfield. The damage to the mill was estimated at between £5,000 and £6,000. It appeared that some millstones had been running empty at the time of the explosion, that a flame was produced between the millstones, which was sufficient to ignite the flour-dust diffused in the millstone cases, and which, being transmitted along the passages to the stive-room by the continued ignition of dust, would cause an explosion of the flour-dust in the stive-room. Mr. Richards has been making general inquiries into the question of fires and explosions in corn-mills. He says that the elements of danger exist in all corn-mills, more or less, and notwithstanding the comparative rareness with which disasters of magnitude occur, they are ever liable to take place. Ignitions of flour-dust are apt to cause slight explosions, which, jarring greater bodies of dust into a cloud, are liable to ignite and cause a serious explosion, or a general firing of the mill. Mr. Chatterton, the Secretary of the Millers' Mutual Fire Insurance Company, informed Mr. Richards that he has records of 84 serious fires which have occurred in corn-mills since 1876, the origin of 56 being unknown. Mr. Richards adds:—"A subject of interest allied to that which has been considered, is that of the risks involved in the cleaning and grinding of rice. The experiments I have made on rice stive-dust and ground rice, convince me of the facility with which they, and particularly the former, will explode when diffused in air. That the risks involved in rice-cleaning and milling are greater even than in corn-milling, is evidently indicated by the high rates of premiums charged by insurance companies, and that some companies will not accept them at any rate. I am informed that the rate of insurance for rice-mills in London is £6 6s. per cent. It is, however, stated to be much less in the country."

INDIAN TEA.—The following figures, showing the growth of the Indian tea trade during the last eleven years, from the Custom-house records, are taken from the second annual report of the Indian Tea Districts Association. The increase in deliveries is 360 per cent.

Amounts imported into this country, and the amounts cleared for home consumption.

	Imports.	Deliveries.
1870	13,148,168	13,472,800
1871	15,351,672	13,560,120
1872	16,924,030	16,272,060
1873	18,424,077	18,392,061
1874	17,377,976	17,756,640
1875	25,605,132	23,273,994
1876	29,383,788	26,733,820
1877	31,883,310	28,011,600
1878	36,007,140	36,766,460
1879	38,483,684	35,243,194
1880	44,010,554	43,500,000
1881	45,765,000	48,500,000

Since 1877 there has been an increase in the consumption of Indian tea of 20½ million lbs., while during the same period there has been a decrease in the consumption of China tea of 9 million lbs.

SULPHUR MINES IN TURKEY.—Some Italian engineers have lately obtained the concession of a large tract of land near the Dardenelles, where a vein of basalt, containing sulphur, has been discovered. This formation, which is similar in character to metalliferous veins (the sulphur evidently having been deposited in the form of vapour on the basalt), is most curious, and differs considerably from the deposits of sulphur in Sicily, which are of sedimentary origin, and are due to certain chemical or physical phenomena whilst the deposition of sediment was going on.

THE LIBRARY.

The following works have been presented to the Library :—

The Water Supply of England and Wales. By Charles E. de Rance, Assoc. Inst. C.E. (London: Edward Stanford, 1882.) Presented by the Author.

Handbook of the Collections Illustrative of the Wild Silks of India in the Indian Section of the South Kensington Museum, with a Catalogue. By Thomas Wardle. (London: South Kensington Museum, 1881.) Presented by the Author.

Official Record of the Sydney International Exhibition, 1879. (Sydney: Thomas Richards, Government Printer, 1881.) Presented by Messrs. Trübner and Co.

Report of the Royal Commissioners for the Australian International Exhibitions. (London: 1882.) Presented by the Royal Commissioners.

Report on the City Day-Census, 1881. (London: Longmans, Green and Co.) Presented by Lord Alfred S. Churchill.

Lessons on Form. By Richard P. Wright. (London: Longmans, Green and Co., 1882.) Presented by the Publishers.

Greek and Roman Sculpture. By Walter Copland Perry. (London: Longmans, Green and Co., 1882.) Presented by the Publishers.

The Herring and the Herring Fishery. By J. W. de Caux. (London: Hamilton, Adams and Co., 1882.) Presented by the Author.

Ashé Pyee, The Superior Country; or the Great Attractions of Burma to British Enterprise and Commerce. By Col. W. F. B. Laurie. (London: W. H. Allen and Co., 1882.) Presented by the Author.

PAMPHLETS.

On the Constitution of the Lines forming the Low-Temperature Spectrum of Oxygen. By Piazzi Smyth, Astronomer-Royal for Scotland. (Reprinted from the Transactions of the Royal Society of Edinburgh, vol. xxx.). Presented by the Author.

Gaseous Spectra in Vacuum Tubes, under small Dispersion and at low Electric Temperature. By Piazzi Smyth, Astronomer-Royal for Scotland. (Reprinted from the Transactions of the Royal Society for Scotland, vol. xxx.). Presented by the Author.

The following have been purchased for the Library :—

Lives of the Engineers. By Samuel Smiles. 3 vols. (London: John Murray, 1862.)

Lives of Boulton and Watt. By Samuel Smiles. (London: John Murray, 1865.)

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

MARCH 15.—"Gas for Lighthouses." (Illustrated by an Exhibition of some of the gas flames and apparatus used in lighthouses.) By JOHN R. WIGHAM. Prof. TYNDALL, F.R.S., will preside.

MARCH 22.—"Telephonic Communication." By LIEUT.-COL. C. E. WEBBER.

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A. Dr. W. J. RUSSELL, F.R.S., will preside.

Meetings after Easter :—

"The Channel Tunnel." By Sir EDWARD WATKIN, Bart.

"The Use and Waste of Public Water Supplies." By G. F. DEACON. Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock :—

MARCH 21.—"Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APRIL 25.—"The Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. NOEL SHORE, author of "The Flight of the Lapwing."

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock :—

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON, F.C.S. Dr. J. H. GILBERT, F.R.S., will preside.

APRIL 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS and PERCY C. GILCHRIST.

MAY 11.—"The Recovery of Sulphur from Alkali Waste by Schaffner's new process, a record of recent results." By ALEXANDER M. CHANCE, of Birmingham.

INDIAN SECTION.

Friday Evenings, at Eight o'clock :—

The meeting announced for March 17th is postponed.

APRIL 21.—"The Mineral Resources of India, and their Development." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

MAY 5.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Third Course will be on "Hydraulic Machinery," by Prof. JOHN PERRY.

LECTURE II.—MARCH 13.

Water at rest and water in motion. The energy law. Gauge notches. Centrifugal pumps and fans Flow of water in pipes. Steam pumps and other reciprocating pumps.

Lecture III.—March 20.

Water-wheels and pressure-engines. Turbines. Measurement of the horse-power given out. Loss of power by friction. Hydraulic fittings, pipes, valves, &c. Accumulators, cranes, and hoists.

Lecture IV.—March 27.

Lifts. The new balance method, as applied in bridges, canal boat, and other lifts. The transmission of power to machines at a distance by means of water. Applications to various tools. Comparison of hydraulic and electrical methods, and the part which each is likely to play in the future.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. John Perry, "Hydraulic Machinery." (Lecture II.)

East India Association, The Hall, 14, Bedford-row, W.C., 3 p.m. Sir Richard Temple, Address on "The Value of India to England."

Institute of Surveyors, 12, Great George-street, S.W.. 8 p.m. Discussion on the paper by Mr. J. E. Bankes, "Distress for Rent."

Society of Chemical Industry (London Section), Burlington-house, W., 7½ p.m. 1. Mr. J. Spiller, "Note on a New Source of Potash Alum." 2. Mr. B. E. R. Newlands, "The Manufacture of Alumina Sulphate."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. Seymour Haden, "The Elements of Etching."

London and Middlesex Archæological, 4, St. Martin's-place, W.C., 8 p.m.

Royal Geographical, University of London, Burlington-gardens, W. 8½ p.m. Mr. H. E. O'Neill, "Three Months' Journey from Mozambique."

Tuesday, March 14...Royal Institution, Albemarle-street, W., 8 p.m. Prof. J. G. McKendrick, "The Mechanism of the Senses." (Lecture IX.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 52, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. Charles B. Bender, "The Design of Structures to Resist Wind Pressure." 2. Jules Gaudard, "The Stability of Structures against the Wind."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. William J. Harris, "The Commercial Advantages of Federation."

Wednesday, March 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John R. Wigham, "Gas for Lighthouses." (Illustrated by an Exhibition of some of the Gas Flames and Apparatus used in Lighthouses.)

Meteorological, 25, Great George-street, S.W., 7 p.m. Exhibition of Anemometers and other recently invented Meteorological Instruments. Historical Sketch by the President, Mr. J. K. Laughton, of the different classes of Anemometers, &c.

Public Analysts, Burlington-house, W., 8 p.m. 1. Mr. P. Vieth, "Milk Analysis." 2. Mr. Otto Hehner, "Some Points in Milk Analysis." 3. Mr. J. Carter Bell, "The Action of Sulphuretted Hydrogen upon Compounds containing Oxide of Iron." 4. Reading of the Letters received by the President in reply to his Circular relating to the "Water Valuation Scale."

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. J. Romilly Allen, "The Sculptured Rocks near Ilkley."

Royal College of Physicians, Pall Mall East, S.W., 5 p.m. (Croonian Lectures.) Sir Joseph Fayrer, "The Climate and Fevers of India." (Lecture I.)

Institute of Bankers, in the Theatre of the London Institution, Finsbury-circus, E.C., 7 p.m. Sir Richard Temple, "The Purchasing Power of the Rupee in India, Relative to Labour Produce, &c."

Thursday, March 16...National Indian Association (at the House of the Society of Arts), 8 p.m. Annual Meeting. Mr. S. M. Israil, "The Education of Mahommedan Ladies, as it is, and as it should be."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Charles Darwin, "The action of Carbonate of Ammonia on the roots of certain plants." 2. Mr. Charles Darwin, "The action of Carbonate of Ammonia on Chlorophyle Bodies." 3. Dr. F. Day, "The British Salmones." 4. Mr. William Phillips, "Observations on the Breaking of the Shropshire Meres."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. Armstrong, "Valency." 2. Messrs. Watson Smith and T. Takamatsu, "Pentathionic Acid." 3. Mr. G. H. Morris, "Some Constituents of Resin Spirit." 4. Mr. B. Smith, "The Preparation of Diethylnaphtylamin, and the Action of Sulphuric Acid on that Substance."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Alfred Tylor, "Roman London."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Resemblances of Sound, Light, and Heat." (Lecture I.)

Royal Historical, 22, Albemarle-street, W., 8 p.m. 1. Dr. J. A. Macpherson, "The Site of the Conference on the Severn (Olney and Deerhurst) between Edmund Ironsides and Canute." 2. Rev. A. R. Pennington, "The Emperor Frederick II. of 13th Century." 3. Rev. S. A. Swaine, "The English Acquisition and Loss of Dunkirk."

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. Thomas Cole, "A Visit to the Birmingham Sewage Works."

Friday, March 17...Royal United Service Inst., Whitehall-yard, 3 p.m. Mr. J. R. Laughton, "Naval Education."

Royal Institution, Albemarle-street, W., 3 p.m. Weekly meeting. 9 p.m. Captain Abney, "Infra Red Rays of the Spectrum."

Philological, University College, W.C., 8 p.m. Dr. Murray, "An Explanation of the Consonant in Grimm's Law."

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Sir Joseph Fayrer, "The Climate and Fevers of India." (Lecture II.)

Saturday, March 18...Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. G. Seeley, "Volcanoes." (Lecture I.)

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FRIDAY, MARCH 17, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the third course, on "Hydraulic Machinery," was delivered by Professor John Perry, on Monday, 13th inst. The subjects specially treated were water at rest and in motion, the energy law, and the flow of water in pipes. Gauge notches, centrifugal pumps and fans, steam pumps, and other reciprocating pumps were described.

Specimens of pumps and other apparatus were kindly lent to illustrate the lecture by Messrs. Thorneycroft and Co., Messrs. Tangye Bros., Messrs. Hayward, Tyler, and Co., Messrs. Warner and Co., Messrs. Stannah, Messrs. Simpson and Co., Messrs. Roe, Messrs. Hett, Messrs. Gwynne, Mr. Coles, Professor Carey Foster, F.R.S., Mr. James Perry, Mr. Ellington, and the City and Guilds of London Institute Technical College. Diagrams were also lent by Messrs. Tangye, Messrs. Stannah, Messrs. Hett, Mr. James Perry, and Professor Unwin.

ALTERATION OF MEETING.

The attention of Members is drawn to the postponement, until after Easter, of Colonel Webber's paper on "Telephonic Communication," which was announced for Wednesday, March 22nd. The paper for that evening will be on "The Tonic Sol-fa System," by J. Spencer Curwen, President of the Tonic Sol-fa College.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefit of which have, however, not been confined to this country, but have extended ove the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, in the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1873, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

The Council invite members of the Society to forward to the Secretary, on or before the 22nd of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, March 9, 1882; J. Spiller, F.C.S., Vice-President of the Photographic Society, in the chair.

The paper read was—

PRACTICAL HINTS ON THE MANUFACTURE OF GELATINE EMULSIONS AND PLATES FOR PHOTOGRAPHIC PURPOSES.

By W. K. Burton.

This paper will, I imagine, be read before a mixed audience, some of whom have a complete knowledge of photographic processes, whilst others may not even know the meaning of the word "emulsion." I shall, therefore, try to explain accurately what we mean by the term, and shall then glance rapidly at the history of emulsions generally, so far addressing myself specially to those who have no knowledge of photography. I shall then enter more particularly into the question of the manufacture of a gelatine emulsion, demonstrating the process; and in this part of my paper I shall address more particularly those whom I suppose to have at least some photographic knowledge.

In all our modern negative processes, the object which we have in view in preparing a plate is to spread evenly on a surface, usually of glass, one of the silver haloids. Those which are used are the bromide, the chloride, or the iodide. Any one of these can be made by combining nitrate of silver with the corresponding soluble haloid. For example, bromide of silver is formed by combining nitrate of silver with any soluble bromide. As an example, I have here a solution of nitrate of silver in water. I have also a solution of bromide of ammonia in water. I pour the one into the other, and a dense white precipitate is thrown down. This is bromide of silver. Now, in the manufacture of every photographic plate, this process takes place. It may either take place on the surface of the plate, in which case we have what is known as a bath plate; or it may take place before the film is spread over the plate, in which case we have an emulsion plate. To explain this matter rather more fully.

I have here a certain slightly coloured transparent fluid. This is what is called "iodised collodion," It is a soluble iodide, dissolved in collodion. Collodion is a substance which will form a thin film over a glass plate. If, therefore, I pour this iodised collodion over this plate, I shall have a film in which there is the substance necessary to form iodide of silver with nitrate of silver, and you will see, that when I drop this plate into a bath containing nitrate of silver solution, it will lose its transparency and become white and opalescent. In fact, iodide of silver is formed on the surface of the plate, and a "bath plate" has been prepared.

Now, this is a very beautiful process, and one which is most pleasing in many ways, but it has its drawbacks. You have seen that, for one thing, some delicate manipulation is required. Not only that, but we are working with two most fickle substances. In practising the wet process, the bath is continually going out of order. If the bath is right, then the collodion is wrong. Then the film itself is of such delicacy that a touch will destroy it; but the great difficulty is, that the plate must be prepared within, say, half-an-hour of the time it is to be used, and when once exposed must be developed within a few minutes, so that the photographer must have the whole paraphernalia necessary to manufacture the plates wherever he means to work them.

Very long ago, it suggested itself to photographers that the two substances, the iodide and the nitrate of silver, might be combined in the collodion before it was poured over the plate, so that the whole process of manufacturing the plate should consist in pouring the collodion over it. I need not enumerate the unsuccessful attempts that were made; suffice it to say that, in 1864, Messrs. Sayce and Bolton succeeded in suspending bromide of silver, in a fine state of division, in collodion, which had afterwards only to be poured over a glass plate. This process I now demonstrate. I pour an alcoholic solution of nitrate of silver into a bromized collodion. You perceive the bromide of silver formed in a fine state of division. All that is necessary is to pour this over the plate to wash the latter, and an emulsion plate has been prepared, and is ready for the camera. You see that the process is far simpler than the bath process, but the very great advantage of it is that, whereas the bath plate had to be used immediately after preparation, the "collodio-bromide" plate may be kept for a lengthened period, either before or after exposure.

The collodio-bromide plate was about the same in sensitiveness as the wet plate, and so long was the dry plate of the day.

It began, after a time, to suggest itself to the minds of various photographers that, possibly, some other vehicle than collodion might be used to hold the bromide of silver in suspension. In 1871, Dr. Maddox suggested gelatine as a medium, and experimented on it, getting good results. He prepared bromide of silver in a solution of gelatine of such a strength that it was liquid when hot, but in the form of a jelly when cold. He spread it over plates when warm, and allowed it first to set as a jelly, and then to dry.

In 1873, Mr. R. Kennett took out a patent for a "pellicle," which was simply emulsion prepared as by Dr. Maddox, but afterwards dried. It had to be re-dissolved in warm water, when plates could be coated with it.

It was not, however, till 1878—when Mr. C. Bennet published the fact that if a gelatine emulsion be kept warm for a number of days, the sensitiveness increases enormously—that gelatine plates came to the front. Mr. Bennet's experiments demonstrated the fact, that in gelatine plates there might be a sensitiveness never before dreamt of by photographers—five times, ten times, or twenty times what they had been used to. It was afterwards shown that if the emulsion be boiled instead of only being kept warm, a very much shorter period of time sufficed to gain the sensitiveness. It was again shown that if the emulsion be kept warm in the presence of ammonia, the process goes on with great rapidity. In 1879, was published a process in which boiling is recommended, but in which it is advised that a very small quantity of the gelatine necessary be introduced before boiling, the rest afterwards. This process is due to Mr. W. B. Bolton. It must be understood that a very considerable quantity of gelatine is required to make a solution which can be spread over glass, and which will "set" as a jelly on the plate; but that a much smaller quantity of gelatine is enough to keep the bromide of silver in suspension while it is being boiled. The advantage to be gained, is that only a small proportion of the gelatine goes through the ordeal of boiling, which is one liable to decompose it.

I have not, up till now, touched at all on the subject of washing an emulsion. I have pointed out that, by combining bromide of ammonium with nitrate of silver, bromide of silver is formed; but we must recollect, also, that nitrate of ammonium is formed, and that this, if left in the emulsion, would be most hurtful. I here give the equation:—

$$Ag\ NO_3 + NH_4\ Br = Ag\ Br + NH_4\ NO_3$$

Besides the nitrate, there is another consideration. It is quite impossible, in practice, to weigh out such accurate quantities of each of the two salts that they shall exactly convert each other. We must have a little of one or the other over, or, as it is said, we must have a slight "excess." This might be either nitrate of silver, or bromide of potassium, but as an excess of nitrate of silver is found hurtful, the proportion of the two haloids are always so adjusted that there shall be an appreciable excess of soluble bromide, or if the emulsion be one to contain a chloride, of soluble chloride. Now, it is necessary, after emulsification and boiling, to get rid both of this excess of soluble haloid and of the nitrate. This is done by washing, and to the washing process, gelatine lends itself admirably. A gelatine solution, in the form of a jelly, is quite insoluble in cold water. All, therefore, that is necessary, is to break up the emulsion when in this form, and to allow it to soak in running water. The nitrate, which is soluble, and the soluble bromide, will each diffuse away.

Now, to pass on to the actual manufacture of an emulsion. The process which has worked best in my hands is the acid boiling process, and this I intend to demonstate to-night. By working exactly as I am now about to do, I obtain plates of the very highest sensitiveness, and at the same time, of good quality.

I need scarcely say, that the operations which I now perform in bright gas-light must, when an emulsion for practical use is wanted, be carried out in the deepest ruby light, and very little of that.

To begin, then, here is the formula:—

I.

Nitrate of silver	400 grs.
Water	8 ozs.

II.

Bromide of ammonium	220 grs.
Iodide of ammonium	15 grs.
Chloride of ammonium	15 grs.
Gelatine (Nelson's No. 1)	80 grs.
Water	8 ozs.
Hydrobromic acid, enough to make the solution just acid.	

III.

Autotype gelatine	450 grs.

soaked in water, and afterwards squeezed to get rid of as much of the water as possible.

A few remarks on the formula.

Iodide is recommended by Captain Abney, and I find that it adds greatly to the quality of the plates. Although chloride of ammonium is used in the preparation of this emulsion, it is not intended that there shall be any chloride of silver in the emulsion. The bromide and iodide are just estimated to convert the silver, using Wernerke's practical equivalents. The reason for using the chloride at all is that I believe a greater degree of sensitiveness is gained by boiling in presence of an excess of chloride than with an excess of bromide. I have not myself been able to find that any advantage arises from the presence of chloride of silver in the emulsion.

The amount of gelatine used in emulsification is rather greater than is sometimes recommended. I believe the quality of the plate is thereby improved. It may be asked why I do not give a definite quantity of acid; it is because the chemicals themselves are frequently acid. I believe that the success in getting a very sensitive, and at the same time clear emulsion, greatly depends on the amount of acidity of the solution. It should be just acid enough to show by litmus paper. If this is the case when the salts are first dissolved, nothing more is wanted. If not, add very dilute hydrobromic acid, till the solution will just turn blue litmus paper red. If it has been neutral at first, about one drop of strong hydrobromic acid will suffice.

I have found the autotype gelatine the best for the bulk, as frilling, in my experience, never occurs with it. It is very hard setting, but at the same time does not repel the developer as some gelatines do. Somewhat more than the quantity given may be used, if it be desired.

To emulsify, I pour the solution, No. 2, into a glass bottle—when at home I use a hock-bottle—I afterwards add, little by little, the nitrate of silver, both solutions having been raised to a temperature somewhere approaching the boiling point. The whole is then poured into a large beaker or jelly-can; this is covered with a cover consisting of a wooden dish and placed in a saucepan. The lid of the latter is put on and the whole is allowed to boil. I coat a plate with the emulsion newly made.

It will be seen that, on looking at a light through the plate, the light appears ruby red. The emulsion is said to be "red by transmitted light." As the process goes on, however, the colour changes, and at last it becomes blue. It is difficult to say exactly when the whole of the bromide of silver has been converted into the blue variety, but it may be discovered by gently drying a plate coated with the emulsion. The blue bromide and the red bromide will separate into patches. When all is converted to the blue, the boiling may cease. The time taken in boiling seems to vary considerably with different manipulators; with me it is generally somewhere between one and two hours, but I have frequently boiled for several hours without producing fog, and have, in fact, never reached the fog-line, so long as the emulsion was kept distinctly but slightly acid. The bulk of the gelatine is then added, and the whole poured out in a flat dish to set.

When it is set quite stiff, it is cut up and placed in the "squeezer." It is pushed through wire gauze into a hair sieve held under water. This cuts it into very small particles, and if water be allowed to run through the sieve for half an hour, the soluble salts will all be washed away.

After this, the sieve is allowed to stand a short time, for some of the water to drain off. The emulsion is then heated, is filtered through two folds of a pocket handkerchief, and is spread on the glass. For this I use a small teapot as a pourer. I used at first to measure the emulsion for each plate, but can now guess the quantity with great accuracy. My teapot holds four ounces, and this will just coat a dozen, or rather eleven, $\frac{1}{2}$-plates. I pour the emulsion on the plate while the latter is on the levelling shelf. I then take a glass rod in the finger and thumb of each hand; dip this rod into the pool of emulsion on the plate—the emulsion runs by capillary attraction along the rod to the edges of the plate, but no further. I lift the glass rod about a sixteenth of an inch; the emulsion rises with it. I pass it rapidly first to one end of the plate then to the other, guiding myself by keeping my thumb and finger on the levelling shelf, and the plate is absolutely evenly coated. It is never removed from the levelling shelf till it is set. The plates are slightly warmed to begin with. The plates, after they are set, are reared on ends in racks, the design for which I got from Mr. G. F. Williams; they are then placed in the drying box to dry.

Plates prepared as I have described are quite as rapid as the average of the so-called instantaneous plates sold commercially. Captain Abney first pointed out that an emulsion got more rapid by keeping it cold after it was washed. In my experience, this only happens when the emulsion is alkaline, or at least not acid. If to the emulsion, made as described above, about eight drops of strong ammonia be added to the pint, it will be found that, after a week's keeping, the plates made from it will be from two to three times quicker than before, and such are quicker than any commercial plates that I have used. This adding of a few drops of ammonia, simply to neutralise any acidity which may be in the emulsion, must be by no means confused with the process where digestion is carried on in the presence of one to two per cent. of ammonia, before washing.

I must say a word on a point that is often discussed. "Is it worth while for an amateur to make his own plates?" I certainly think it is not, if he expects to economise by it. If, however, he is such an enthusiast as to make plates for the pleasure he will derive from working those made by himself, instead of those purchased, then by all means let him make them, but do not let him suppose that everything is to go quite smoothly, and that he is to have no trouble—at least, if he is aiming at rapid plates. It is easy to make a moderately rapid emulsion, and to make a number in succession with uniformity, but it is not so easy to make the plates. It is on the coating and drying of the plates that the difficulty comes. Then, if an exceedingly rapid emulsion is required, the difficulties increase, and, in fact, become very great; the amount of light admissible is so small, that manipulation must be performed more by feeling than by seeing.

We often hear people grumbling at the quality of commercial plates. My own surprise has been at the uniform excellence of the plates issued by all the leading manufacturers. If any amateur reaches the quality and uniformity of any of our first manufacturers, he may be well pleased with himself.

DISCUSSION.

The CHAIRMAN said he was very glad to see such a large and influential gathering of photographers present, and he would ask Dr. Maddox to begin the discussion.

Dr. MADDOX said he feared he was somewhat in arrear now with regard to the particular subject which had been so ably brought before them that evening, but he might attempt to give an answer to a question which Mr. Burton had put to him before entering the room, as to how he managed to avoid red or green fog. In the first place, he used bromide of cadmium and excess of nitrate of silver; so when, after flooding with water, he used pyrogallic acid as a simple developer, he had a solution on the surface of the plate of only a small quantity of nitrate of cadmium and nitrate of silver, as the plate was in a hygrometric condition, and the consequence was he generally got very little red or green fog, though he was not without examples of it, as was shown by one of the cards exhibited. Indeed, he thought it was one of the best examples to be found in London, for one half the picture was red, and the other green; how it was obtained he did not remember. The development was further followed up by pyrogallic acid, with a little nitrate of silver and citric acid. The plate was afterwards washed and cleared by hyposulphite in the ordinary way. That was the simple process he employed at first; but, unfortunately, he had not time to follow up the advantages he saw in the present emulsion process, and, therefore, the chief honour should be awarded to those who had come after him and perfected the process.

Mr. Kennett said he had been connected in this matter from the earliest days; in fact, he might say, he brought out the first workable gelatine plate. He began his experiments in 1858, but the matter was left in abeyance until 1873, when Mr. Burgess brought out an emulsion. Having seen his advertisement, and obtaining some of the emulsion, it struck him it was very like what he had made years before, and he immediately set to work and made an emulsion, a notice of which he sent to Mr. Burgess, inviting that gentleman to come and see what he was doing. Mr. Burgess called, and on seeing what had been done, at once admitted that what he saw had far surpassed anything he had done, at that time, though he said he had been working at it for five years. From that time he (Mr. Kennett) had followed the matter up, and in June, 1874, read a paper on the subject before the parent Photographic Society, showing at that time both the pellicle and plates made from the gelatine emulsion, with negatives taken in the same. He was not then making plates commercially, merely pellicle, but the broad fact of making the pellicle made an instantaneous plate, inasmuch as the emulsion had to be kept heated for a number of hours, sometimes 24 hours or more, according to the temperature employed to desiccate it, and this pellicle, when used to coat plates, unless otherwise treated, gives an instantaneous plate. He had letters, and samples of instantaneous exposures, sent him from all parts of the world, taken on his plates, as well as from Mr. Bennett himself in 1875, ordering instantaneous plates, and showing him (Mr. Kennett) pictures, taken on his plates, of one steamer passing another. How, then, anyone could come forward and claim to be the first to make instantaneous plates after such plates had been in use for fully five years, he was at a loss to understand. He merely wished to mention this as a historical fact.

Mr. England, in reference to the statement of Mr. Burton, that he had been less successful with the ammonia process than with the boiling, said he had tried both methods lately, and had been much more successful with the ammonia nitrate process than the other. He had had two years' experience now in it, but he was indebted to Mr. Cowan for the formula with which he was working.

Mr. Cowan said he was quite an apprentice in emulsion making, and scarcely liked to offer any remarks. He had not tried the method now described, and, therefore, could not say anything for or against it. He had made a great many emulsions with ammonia, and by the ordinary boiling process, but should give the preference, as far as he knew, to the ammonia nitrate process, as giving the clearest, quickest, and most certain plates, with less amount of trouble than in any other way. The formula which Mr. England spoke of was not entirely his, but was a modification of the first one he saw published by Dr. Eder, one point being that, instead of using the whole bulk of gelatine to emulsify, he used a portion, and another point was that he always used a large excess of bromide, for which he was indebted to Capt. Abney.

The Secretary (Mr. H. Trueman Wood) said he was very glad to have the opportunity of congratulating Mr. Burton for the admirable way in which he had put this interesting subject before the meeting. He was sure they would all agree with him that Mr. Burton's paper formed a most excellent appendix to the admirable series of lectures which they had had from Capt. Abney, inasmuch as it took up the subject where Capt. Abney had left it, and gave the details of the newest and latest researches of photographers. Most of those present knew better than he did the various details connected with making gelatine plates; but there were one or two points to which perhaps even a beginner might direct attention with the view of promoting further discussion. First, with regard to the mixture of the various ingredients, he should like to know whether Mr. Burton had tried the effect of diluting his silver rather more largely, using a less proportion of water in the gelatine. The idea was put out the other day by Mr. Stenning, at a meeting of the Amateur Field Club, and having heard what was said about it, he went home and tried it. He must say he found better results than he had previously got by putting as much water as he dared along with the silver, and only using just a sufficient amount of water with the gelatine and bromide to dissolve the gelatine. It was a simpler way of getting the emulsion into the fine state of division, which was the great desideratum.

Another point was the emulsifying. Some time ago, Mr. Warnerke described a very simple apparatus for doing that, which consisted of a funnel with a piece of india-rubber tube and a piece of glass tube drawn to a fine point. You poured the silver solution into the funnel, and while it was running out through the india-rubber tube and the glass tube, you stirred round the gelatine, the effect of which was to mix the two solutions thoroughly; and from one or two experiments he had tried, he found he got a finer emulsion than in the way Mr. Burton described, by shaking up the solutions in the bottle. Again, as another matter of detail, he did not see that much was gained by pouring the emulsion out in a flat dish to set, unless you were in a hurry to carry the operation right through, and made the plates at the same time as you made the emulsion. If you mixed it first in a jar, boiled it in the same jar, and let it set in the same jar, it saved some trouble. The apparatus Mr. Burton used for cutting up his emulsion was very convenient, but he must say it was very likely to have little bits of old and decayed emulsion left on it, which were very difficult to get rid of, and interfered very seriously with the new emulsion. He had used an apparatus of the same kind which was made of glass, and was nice and clean, but, unluckily, the glass was easily broken. Since then he had gone back to the old plan of breaking up the emulsion by squeezing it through a piece of canvas. There were obvious advantages in the mode, because you could boil the canvas as often as you liked, to get rid of the old emulsion, and when you were tired of doing that, you might throw it away. He should recommend all amateurs not specially skilled in manipulation, to try Mr. Burton's extremely handy and simple method of coating the plates with a glass rod. There was no doubt that even people who did not make emulsion in large quantities, could make the emulsion very easily; but the real difficulty was to get the plates properly coated, and when done, to get them dried without those beautiful marks which Mr. Burton had shown. Again, for an amateur, it really was a question whether one should make one's own plates, or buy them. As a matter of pounds, shillings, and pence, looking at it for your amusement, and charging nothing for your own time, you might save a shilling or two per dozen on moderate sizes, and there was a satisfaction in using plates you had made yourself, but for himself, he must say if he wanted to be quite sure of getting a nice picture, he did not mind confessing he preferred to rely on some established manufacturer. It had puzzled him a great deal why some makers charged so much more for plates than others. One could get very good plates very cheap, and also very dear, and the only difference he could see in them was that the higher priced plates were, perhaps, more certain; one could rely on not getting any scratched plates, or plates with thin or thick corners, and the dearer plates always seemed to be on better glass, which was an important point, but he hoped, as photography extended, and there was more demand, the makers would all come down more to a level.

Mr. YORKE hoped Mr. Burton would state what temperature he used for drying the plates, and how he regulated it.

Mr. BOLAS said he had obtained better results by the ammonia process than by other methods. With regard to Mr. Kennett's claim to be the first producer of instantaneous plates, it was a question whether daguerreotypes ought not to be considered the first instantaneous plates.

Mr. HOWARD said a matter had been mentioned that evening by Mr. Wood, which he thought ultimately would be of great importance to the photographic community. This was the first time any public notice had been taken of the important discovery that Stenning and Conway had made in the method of mixing the solutions. He had lately been going through a series of experiments in the method, and no doubt it was a most important discovery. You could at once, in a very small time—in five minutes' boiling—produce an enclusion plate as sensitive as one produced by prolonged boiling. He must add that Mr. Sebastian Davies could also corroborate this statement.

Mr. MAXWELL LYTE said he was a very old photographer, but he was sorry to say he had been obliged to leave off photography before these new discoveries had been brought about, though he had worked from 1844 down to 1866. He should like to ask what quantity of hydrobromic acid Mr. Burton added to his emulsion. It seemed to him that if he added such a very small quantity as they were led to suppose, possibly the acidulation of the gelatine emulsion was not really due to free hydrobromic acid, but that the hydrobromic acid added, would probably set free another acid, and he would suggest that a trace of phosphoric acid might be set free, because gelatine almost always contained slight traces of phosphates. When gelatine was burnt traces of phosphates were almost always found in the ashes, and sometimes considerable traces; consequently, he should think it possible that the acid set free being phosphoric acid, the acidulated gelatine might act in a much milder sort of manner than were the free acid really hydrobromic acid. Possibly, that might account for the fact that the added hydrobromic acid did not retard so much the action of the light as it otherwise might. This diminished retardation due to phosphoric acid might account for the small difference observable between the ammonia process and the hydrobromic acid processs, as he might call Mr. Burton's. He should like also to ask whether the washing water was always distilled water, or whether ordinary rain water would serve. If it were rain water, it would contain slight traces of ammonia, and if such rain water was continually poured over the surface of gelatine in a fine state of division, there might be considerable effect produced by that means, and a final condition of neutrality, if not of alkalinity, might result.

Dr. MANN, being called upon, said he could only say a few words from the point of view of an amateur, who, over and above the interest of a photographer in his work, had a great desire to have a ready means of securing records in various scientific pursuits. He commenced his humble work as a photographer in South Africa many years ago, and during that time worked often blunderingly, doing the best he could under such difficulties as having occasionally to see the collodion boiling whenever the stopper was taken out of the bottle; and he had now by him a great many interesting reminders of his life there, which lasted for nine years. Many of these were poor things as pictures, but, nevertheless, interesting and valuable in some scientific or ethnological point of view. Now he could not but think, when he looked upon what is at present being done, of what he should have brought home for those nine years' work in South Africa, if he had only had dry gelatine plates to work with. It would have been like multiplying his results, and saving his time a hundredfold. From that point of view, he was very glad to welcome these wonderful improvements, and congratulated photographers at large on the additional facilities which their successful labours placed in the hands of scientific men to enable them to secure results from their works. All scientific men were enormously indebted to photography, and were getting to be more and more indebted to photographers.

Mr. J. M. THOMSON said he was going to ask the same question as Mr. Maxwell Lyte had put with regard to hydrobromic acid. It seemed to him, looking at it from merely a chemical point of view, that another acid might be set free, for if you added it before the silver you would free hydroidic acid from the iodide, as they knew that free hydrobromic acid would free that acid.

Mr. MAXWELL LYTE said if you took silver nitrate and added it to a mixed solution containing any soluble chlorides, bromides, and iodides, the first substance which would precipitate was pure iodide of silver, the second pure bromide of silver, but not until all the iodide had been precipitated, and it was only subsequently that the chloride of silver became finally thrown down. The affinities with respect to silver of iodine, bromine, and chlorine were reversed in comparison to what they were with regard to most other metals.

Mr. THOMSON said his observations were directed to what happened before adding the silver nitrate.

Mr. MAXWELL LYTE said the free hydrobromic acid would, as Mr. Thomson had observed, set free hydriodic acid, but then immediately the silver was added you would have a production of silver iodide, and hydrobromic acid would be set free in virtue of the particular conditions and the relative affinities of iodine, bromine, and chlorine for silver.

Mr. W. COBB said he had been lately working with a formula similar to that used to-night, and could quite bear out what Mr. Burton had said as to the quality of the plates produced. They were very fine indeed. At the same time, he had not found such rapidity with the formula as with the ammonia nitrate or other methods of working with ammonia. He had been lately trying the method of actually boiling the emulsion with ammonia, and he produced one absolutely free from fog by that means. The plates produced by Mr. Burton's formula had certainly a great charm for their brilliancy and quality.

Mr. BURTON, in reply, said he thought Mr. Kennett was quite right in saying that he was the first producer of instantaneous plates, but the credit due to Mr. Bennet was not for producing those plates, but for publishing the process, whereby the public were enabled to make instantaneous plates for themselves. As regards the question some of the members had taken up—the difference between the ammonia nitrate and the boiling process—all he could say was, that it was a question of the difference of experience. He had, and did produce plates by the boiling process more rapid than any commercial plates he had worked with. He could not say more rapid than any, because, on one occasion, Mr. Henderson had given him some which he said were produced by the ammonia nitrate process, which were marvellously rapid; but with that one exception, he had never got plates so rapid as by his own method, and the quality was, in his opinion, decidedly better than by the ammonia process. He knew Mr. Cowan got the most excellent plates possible with the ammonia nitrate process, but he had failed to do so himself. With regard to Mr. Wood's remarks, he could not say he had tried the effect of greatly diluting the nitrate of silver, but certainly, from what he had said, and having the high authority of Mr. Frank Howard on the subject, he should give it an early trial. As regards emulsifying, Mr. Wood said he had got a finer emulsion by allowing one solution to dribble into the other, but his experience was quite the contrary. A very good gauge of the efficiency of an emulsifying process was, how much bromide of silver could be suspended in a given quantity of gelatine. He had found by adding little by little, and by shaking up in a bottle, he had been able to suspend in a certain small quantity of gelatine a greater quantity of bromide of silver than by any other method. As Mr. Wood very aptly pointed out, there was not the smallest necessity for pouring the emulsion into a flat dish. If you wanted to break the process, the point at which to do so was after the bulk of the gelatine had been added, it would then keep almost indefinitely, and would set very nicely, and could be taken out at any time to be washed. He could not agree with Mr. Wood with regard to the canvas. He tried it a long time, and found it a weariness of the flesh, the mess made by it was something horrible, and he was very happy indeed when some one pointed out the way in which the breaking up could be effected, by squeezing through copper-wire gauze. Mr. Yorke had asked a very important question, namely, the temperature of the coating and drying-room. As regards coating, with the gelatine he used, he preferred to have the room about 60° or 65°; if colder than that, he had to warm it. 65° was the highest that ought ever to be used for drying, unless the natural heat of the air was greater. By lowering the air below the natural temperature, you produced a certain amount of dampness. The temperature, in his experience, should never be raised above 65°. If you had a very dry room, you might keep it below that. As regards the method of applying heat, he used a very small room, which he heated with a gas-stove, the products of the combustion of which were carried outside; if he were working in a large room, he should arrange to draw air down the outside of the flue from the draught-box between it and a sliding cylinder fitted outside of it. Mr. Lyte had introduced a most important question with regard to the acid. He had already said that he did not believe that hydrobromic acid had any advantage over any other; he simply used it because it was symmetrical with the other ingredients. He believed it was the physical effect of the acid, not the chemical, which was advantageous. He had used citric acid, nitric acid, and hydrochloric acid; as regards the amount, if the solutions were perfectly neutral to begin with, from one to two drops of strong hydrobromic acid was quite sufficient. It was certainly not necessary to use distilled water. Tap water might be used throughout. It was advisable to mix up the silver solution with distilled water if for no other reason than that the chlorides which were in ordinary tap water produced a certain amount of chloride of silver, which might be acted upon by daylight, and produce a slight fog. There was no doubt, as Mr. Lyte said, that any tap water or spring water was, as a rule, slightly alkaline, but he had not found it to neutralise the acidity of an emulsion. On testing the emulsion with test paper before the after-washing, he found no change, or at any rate, it was slightly acid both at the beginning and at the end of the process. As regards the iodide, bromide, and chloride, Mr. Lyte had stated that they combined with nitrate of silver in the order mentioned; and if Mr. Lyte had followed his remarks with regard to the formula, he would have seen that he (Mr. Burton) depended on that for having no chloride of silver in the emulsion. He wanted the emulsion to consist solely of bromide and iodide, and to boil that in the presence of soluble chloride, because he believed that gave higher sensitiveness. That, he believed, had not been generally done, and possibly that might be the reason why so many gentlemen found they got greater sensitiveness by using the ammonia nitrate method. He would recommend them to use an emulsion in which the excess was chloride, and not bromide. With regard to Mr. Cobb, who said he could not get rapidity by this formula, he had brought him some long promised plates, which he hoped he would try, and if he did not find them rapid, he should be very much surprised. He was astonished to hear that he had been successful in boiling the emulsion in the presence o ammonia without producing fog; but he would suggest to him that all the ammonia might have been driven off before the emulsion had reached the boiling point.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Burton for the interesting paper he had given, which had led to a most interesting discussion. He would not trouble the meeting with any remarks from himself, because this was not a subject with which he was intimately acquainted. He had worked with gelatine plates, but they had not been those of his own manufacture. He might say that he found it perfectly possible to expose a view in the camera one day and develop the plate at the expiration of a year, which was indeed a fact in photography. He knew of no other process than this, except perhaps the old daguerreotype, where it was possible to do so. [The Chairman here exhibited two views, one of which had been developed after nine months, and another after twelve months.] He might conclude by saying that this subject of gelatine photography was one which might engage, not one evening alone, but many—in fact, a whole course or lectures might be given on this one subject.

The vote of thanks was passed unanimously, and the meeting adjourned.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 15th, 1882; Professor JOHN TYNDALL, D.C.L., LL.D., F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Barclay, Arthur, M.I.M.E., 12, York-street, Covent-garden, W.C.
Brown, George William, M.I.M.E., Reading Iron Works, Limited, Reading.
Calthorpe, Lieut.-General the Hon. Somerset G. Woodlands, Ryde, Isle of Wight.
Fenwick, Clennell, Victoria Docks Engine Works, Victoria-docks, E.
Harfield, William Horatio, Mansion-house-buildings, E.C.
Harris, William Wallington, 24, Alexandra-villas, Hornsey-park, N.
Harwood, Robert, Vale Bank, Bolton, Lancashire.
Macay, Juan Francisco N., 79, Coleman-street, E.C.
Mills, Miss Emily, Queen's College, 70, Upper Tollington-park, N.
Sellon, John Scudamore, 79, Hatton-garden, E.C., and Sydenham-hill, S.E.
Tracy, Hon. Hubert Hanbury, Brooks's Club, S.W.

Winser, John Johnson, Laetaville, 7, Cloudesley-street, Barnsbury, N., and Lincoln's-inn-chambers, 40, Chancery-lane, W.C.

The following Candidates were balloted for and duly elected Members of the Society:—

Fletcher, Thomas, F.C.S., Museum-street, Warrington.
Moritz, Edward, Ph.D., F.C.S., 72, Chancery-lane, W.C.
Neison, Cuthbert G., Ph.D., 173, Fenchurch-street, E.C., and East London Chemical Works, Mile-end, E.
Preston, William Howel, 8, Victoria-street, Westminster, S.W.
Robinson, J., Bryn-y-Mor-house, Llanfairfechan, North Wales.
Robinson, John, M.I.C.E., Westwood-hall, Leek.
Steuart, David Vincent, Albert Chemical Works, Clayton, Manchester.
Webb, Charles S., 16, Coleman-street, E.C.
Webster, Ernest William, The Firs, Waltham Abbey.

The paper read was—

GAS FOR LIGHTHOUSES; ILLUSTRATED BY AN EXHIBITION OF SOME OF THE GAS FLAMES AND APPARATUS USED IN LIGHTHOUSES.

By John R. Wigham.

A century has just elapsed since a native of Geneva, Aimé Argand, did great service to artificial illumination by the introduction of the lamp which bears his name. It may be said of his important invention, that when it left his hands it was practically perfect. The Argand burner of to-day is substantially the same as that constructed by him in 1782, and the principle on which it was constructed is the basis of all the oil lamps and gas lamps which have cylindrical flames to the interior of which a stream of air is admitted, to promote combustion, while a similar current is brought to the exterior by the use of a glass chimney.

Notwithstanding the manifest advantages of the Argand lamp, lighthouse authorities were slow to adopt it. We find that, more than 30 years after its introduction (in 1816), the light of the Island of May (Firth of Forth) was from a coal fire; and the famous Eddystone had only tallow candles as its illuminant till 1807, when they gave place to Argand lamps with parabolic reflectors. Here is one of these lamps as at present used, with its reflector. This burner is one of the Trinity-house pattern, its flame is from colza oil, but it is also capable of being used for paraffin oil. With either, good flames are produced, but a still better light may be obtained from a gas-burner such as this, which requires no glass chimney, and is easier of manipulation. I will presently substitute it for the oil-burner. I get much more light, and I can increase its power for foggy weather in a moment, and equally quickly reduce it again to the strength required for clear weather. The light from oil lamps can also be increased for foggy weather, but not so easily as is the case with gas.

I will now light the gas-burner in the reflector. This smaller parabolic reflector is the size used for floating lights. You will see that it is mounted in such a manner that, no matter how much the ship may roll or pitch, the light is maintained perfectly level.

Catoptric Lights.

These reflector lights at which we have been looking are still much used in lighthouses, both for fixed and revolving lights. You have seen, as I moved them up and down, that the light was reflected from every part of the reflector, and that it was transmitted in a nearly parallel beam. For a first order lighthouse, a number of, say 20 to 26 of such reflectors, are placed side by side and over each other, in the manner shown in the diagram on the wall. The lights of the lamps blend and show a great illuminated surface to the observer. This constitutes what is called the catoptric system of lights.

Intermittent Lights.

The use of gas for all lighthouse lamps has this great advantage over oil, that where intermittent lights are required, gas is not only turned off and on very easily, but at each intermission the consumption of gas is stayed. This cannot take place when oil is used, for the oil lamp must be eclipsed by the interposition of opaque shades, the consumption of oil continuing all the time of each eclipse, whereas gas flames are extinguished by cutting off the supply of gas, and thus, during the period of darkness, the consumption of the gas is saved.

Whilst speaking of intermittent lights, perhaps I may further say in this place, that for lighthouses not only have we in gas a source of illumination superior, in my mind, to any other, but also an exceedingly useful motive power. I do not now refer to gas-engines, the great value of which for lighthouse purposes I shall have to mention further on, but to the ordinary pressure of gas, by which we are enabled, in some cases, to actuate mechanism for causing the intermissions of the light, and thus dispense with the costly clockwork usually employed for the purpose. We are all familiar with the gas "Barker's-mill," by which lights of gas are caused to revolve simply by the force with which the gas issues from the orifices at which it is burned. This is one example of the motive power to which I refer. Again, the great draught caused by the ignition of gas under tubes such as those now used at lighthouses is capable of rotating a powerful fan, by which the valves admitting the gas to the burners may be turned on and off as required. Another method for turning gas off and on automaticlly, which I have recently devised, is shown by a diagram on the wall. The heat of the gas flame expands air in the copper ball suspended over it. This expansion of the air raises a column of mercury in the tube connected with the ball, and the mercury thus raised cuts off the supply of gas to the burner, by sealing the mouth of the tube through which the gas issues. As soon as the gas is extinguished, the air in the ball becomes reduced to its normal density, and the mouth of the gas tube is unsealed, causing the flame to spring up as before. Of course, a small bye-pass is used, admitting an almost invisible flame to the burner, for the purpose of re-lighting it. This method of automatically intermitting lights is not practicable under the oil system.

Cost of Gas.

The cost of gas, even when fixed lights are used, is but little in excess of oil. The Parliamentary papers, which have been published, show that the annual cost of a gas station is, in some cases, greater by about £40, than an oil station; but they also show that the cost of gas is much less than oil when the cost of the fog powers of the former is not added, and that taking the superior light of the gas into consideration, its cost is much less than oil. (See Appendix.)

Dioptric Lights.

Fresnel, the great French optician, and the not less eminent Scottish philosopher, Sir David Brewster, are both entitled to the honour of introducing for lighthouses what is known as the dioptric system. In this system, instead of using many small lights, each in the focus of its own reflector, one large lamp only is employed, and fixed in the centre of cut-glass lenses, which refract the light and transmit it to the horizon, performing precisely the same office as reflectors, but doing the work in a different manner. I have here dioptric apparatus for a "fixed light" of what is called the first order. You will see that it is divided into three portions, the centre (which is called the great refracting belt), the top zones (or prisms), and the bottom prisms. The effect of this apparatus is to send a parallel beam to every part of the horizon. I have also here, this annular lens, also of the first order for revolving lights, and as I thought you would be interested in seeing practically the effect of lenses for revolving lights, I have arranged it so that it may be moved, and cause its characteristic beams or flashes of light. It is, perhaps, needless to mention, that the power of each beam from a revolving light is vastly greater than that from a fixed light, inasmuch as in the case of the latter, the light radiates from the centre to the whole horizon, but in the former it is intercepted, and condensed into eight beams. It is obvious that these powerful beams would never reach all parts of the horizon, if the apparatus were not caused to revolve. You will notice that the angles of darkness are very large. I hope to show you practically, when we light our burners, how small a portion each beam illuminates when not revolving. We are (this evening) indebted to the Commissioners of Irish Lights for the use of these dioptric apparatus which they have kindly lent me for experimental purposes.

The oil lamps which are used for dioptric apparatus are Argand lamps, having concentric wicks, 2, 3, 4, and 6 in number. Here is a 4-wick lamp and chimney. I have not lighted it, because it is difficult in a room like this to maintain the perfectly even draught in in the flue which surmounts the glass chimney, without which draught the lamp is liable to smoke, and vary in illuminating power. A full-sized drawing of this lamp is on the wall, and also one of the 6-wick oil lamp, which is the largest in use. I am informed that still larger lamps are being experimented upon. If the experiments prove successful it will be important for some lighthouses, for—for the reasons which will presently appear—I consider an increase in the size of our lighthouse illuminants will be of great advantage.

I come now to the main subject for our meeting to-night, viz., the introduction of gas for dioptric lights for first-order lighthouses. It is perhaps known to some who are present that the Commissioners of Irish Lights were the first lighthouse authorities to make use of gas as an illuminant for important lighthouses. They have done me the honour of adopting the arrangements and burners for the consumption of gas which I have devised from time to time. My aim has been to obtain the greatest possible intensity with the greatest possible volume in the gas flames which I employed. Before showing you these flames, I may perhaps be permitted, for a few minutes, to explain some of the steps by which I was led to construct gas burners for lighthouses in the form in which they are now used.

CONSTRUCTION OF BURNERS.

As I have before stated, only Argand burners have been used for the combustion of oil in first-order lighthouses, and one of the first things I did, was to construct Argand burners for gas, with concentric rings. I also, by a very simple process, converted the 4-wick oil lamps into 4-ring Argand gas burners, and burned the gas with an ordinary oil lamp chimney. Here is a lamp which I altered in this way many years ago. I found that by carefully regulating the air passages, a good light in both cases was obtained, but that the full advantages of rich cannel gas, which, for obvious reasons, is that used at lighthouses, could not be developed by Argand burners. The fact that Argand burners do not give as good photometric results with rich, as with poor gas, has been long known to gas engineers. I proved it to my own satisfaction by my experiments, and I also found that glass chimneys for large lights were troublesome, liable to breakage from accident, as well as from varying temperature, and required careful cleaning; besides which, the cleanest glass presents some obstruction to the transmission of light. I therefore sought for another plan of applying gas which would not have the disadvantage of requiring the use of glass, and would develop the full power of cannel gas. It occurred to me that if any plan could be devised by which the excess of carbon—the smoke—existing in rich gas flames, could be turned to account, as a means of increasing their illuminating power, a valuable desideratum would be obtained. I accordingly made many experiments with that object, and came to the conclusion that I could find no better basis for my efforts to that end, than the ordinary well known fish-tail jet, or a combination of burners or jets of the fish-tail or bat's-wing type. The fish-tail jet, it is hardly necessary to say, is bored diagonally on opposite sides of a small internal cone. The streams of gas issuing from the orifices impinge against each other with considerable force, and the result is the thin sheet of flame with which we are so familiar. This flame possessing a large surface, to which the oxygen of the air readily gains access, is in consequence rendered brilliant and comparatively smokeless. But on closely examining the flame of a fish-tail burner, it will be seen that towards the top, where the force of the stream of gas is nearly expended, it is thicker and inclined to be smoky. The larger the bore of the burner the thicker the stream of gas, and (its pressure and quality being good) the greater the amount of unconsumed carbon. When a number of fish-tails are arranged so that the upper extremities of their flames touch each other, they run up (because of the absence of air between each jet) into somewhat smoky tails; but the light they give when thus united is increased, with hardly any increased consumption of gas, much beyond the mere multiple of the illuminating power of their single flames, as may be seen in a moment by bringing two fish-tails together. I made this peculiarity of the fish-tail available for producing a large flame of highly illuminating power, and I devised this form of burner. I used in its construction double jets (a simple form of governor), by which a more effective combustion of gas is attained with less consumption for each jet than in the burners which I used in my earlier experiments. The principle of the double jet is not new, but I believe that the present form of its application was entirely so. It is exceedingly simple, and may be explained by this ordinary gas burner. Having thus obtained a maximum of illuminating power from each jet, it remained to build up of such burners a flame suitable for lighthouses, and in doing so, to make use of means to utilise the smoky part of the united flame. I accordingly placed an overhanging flue of suitable size above the burners, so as to effect this object by the indraught of air upon the top of the flame. The power of the burner is, therefore, obtained not only by the peculiar arrangement of numerous fish-tail jets, but by suspending over the flame which they unitedly produce, an oxidiser of talc or other material, by means of which a current of air is brought into contact with its most smoky part, rendering it not only smokeless but exceedingly white. The combustion is also assisted by a bottom cone, for equalising the current of air to the flame. The oxygen of the air is thus twice utilised, first, at the bottom of the flame, through the medium of the several fish-tail burners; and, secondly, at the top of it, where its action raises to a white heat the large quantity of solid carbon found there. This may be seen if I light the burner, which, I may mention, is of the size used for ordinary clear weather in lighthouses.

POWER OF BURNERS.

I have here a complete lighthouse gas burner. It is so constructed that a light-keeper can increase the power of the light by five steps, according as the state of the weather may require from the burner used in clear weather, consisting of 28 jets, such as I have just lighted, to the second, third, fourth, and fifth fog-powers, consisting of 48, 68, 88, and 108 jets respectively. The illuminating power of each of these burners, as ascertained by Dr. Tyndall, in an official investigation which he made on the subject at Haisbro' Lighthouse, as shown in the table on the wall, as respectively 429, 832, 1,253, 2,408, and 2,923 standard sperm candles, while the power of the largest lighthouse oil lamp at present used is but 722 candles. The changes from one power to another can be made very quickly by the use of a peculiar arrangement of mercurial joints, as I shall now show you.

These large burners, at which we have just been looking, may be termed fog-burners. We all know, especially those among us who reside much in London, that there are fogs capable of obscuring any artificial light, and that even the sun's rays can but feebly penetrate dense fog, but, at sea, when fogs are not very dense, or when the weather is merely what is called thick, and sufficiently so to obscure ordinary lights, then it is, that the mariner derives the benefit of the powerful lights such as I have just shown you. These gas-lights are used at six lighthouses in Ireland—Howth Bailey, Rocabill, St. John's Point, Wicklow Head, Mine Head, and Hook Tower, and at the two Haisbro' lighthouses in England. They are also used in a different form at Galley Head, county Cork, as I will presently mention more particularly. Some of these lights have been 17 years in use; they have never failed, and have always given great satisfaction to the sailors using them. Dr. Tyndall, scientific adviser to the Board of Trade, examined these lights from time to time, and reported upon them. His reports agree with those of the mariners, and they very authoritatively pronounce gas for lighthouses to be superior to all oils. It may be asked under such circumstances, why the system has not made further progress, and why, with one exception, no lighthouse has been supplied with gas since 1873. In 1875, the Trinity House advised that the gas system should be further developed, but the development has not taken place. The Commissioners of Irish Lights have again and again asked the sanction of the Board of Trade for the further extension of the system, but the extension has not taken place, although there is now some sign of improvement. This is not the time nor the place to investigate this part of the subject. Perhaps, some time, a chapter may be written upon it; but meanwhile I think I may venture to say that the delay has not arisen from any inherent defects in the gas system, or because a better plan has superseded it; all the evidence is the other way. Mariners still think as highly of it as when it was first introduced, and quite recently, the Commissioners of Irish Lights received testimony from captains of steamers passing their gas-lights, to the effect that in fogs, by their means, they could ascertain the position of a lighthouse when, owing to the thickness of the weather, an ordinary lighthouse could not be seen. I will now light a gas-burner in each of the two kinds of dioptric apparatus which are here, and will move the annular lens that you may judge of the comparative effect of revolving lights and fixed lights.

LARGER LENSES.

If, instead of using any of these ordinary lighthouse lenses, which were designed for oil lamp flames, 4 inches in diameter, by 3½ inches high, I were to use a lens made to suit my large 108-jet gas flame, which is nearly 12 inches in diameter, by 8½ inches high, I need not say the illuminating effect would be enormously greater. I trust, before long, lighthouse authorities will sanction the construction of such lenses, and so gain the full benefit of the large flames, which have, so far, been only produced by gas.

QUADRIFORM LIGHT.

Being fully convinced, from long practical observation, of the importance to the sailor of using large lights in illuminating fog, I determined to push that principle to the utmost limit permitted by the lenses now used in lighthouses, and I devised a plan, by which, in foggy weather, double, treble, and quadruple the power of the largest gas light and lens at which we have been looking, can be obtained. This plan, which has been termed the biform, triform, and quadriform system, consists in placing two, three, or four burners, vertically, over one another, and making an arrangement by which the products of the combustion of the lower burners are intercepted and turned outwards, so as not to interfere with the upper burners, while a supply of pure air is conveyed to each of them by cylindrical openings, brought through the flues. The air thus introduced is sucked in briskly by the draught, and much heated by its contact with the nearly red-hot casing of the internal flue, as is also the gas, the pipes for which are in the hot chamber. The illuminating power of the upper flames is materially increased by this arrangement.

That you may clearly understand the manner in which these lights are burned one above another, I have here arranged two such lights of small size, and you will observe that so far from the upper being injuriously affected by the lower light, it is improved by the high temperature at which it is burned, and the constant supply of fresh air which is sucked in by the apparatus which I have described. Without this apparatus, the upper lights would have hardly any illuminating power.

I have here a model of the quadriform apparatus at Galley Head. There are 32 lenses arranged in four tiers, 8 in each tier. Each lens is of the size of this first-order lens, and one of these powerful gas-lights is placed in the focus of each tier; thus there are eight pillars of light, about 13 ft. 6 in. high, and 3 ft. wide, the great beams from which are continually visiting every part of the horizon. A full-size elevation of the lenses is on the wall.

The great illuminating power (calculated to be more than a million candles) of this lighthouse, it is to be remembered, is completely under the control of the lightkeeper; only one-fourth of it is applied in clear weather, the other three portions being added as the weather thickens. This light, though the largest in the world, is also one of the most economical, only about one half of the quantity of gas which would be used in an ordinary flashing light being consumed. This arises from its being what is termed a group flashing-light, that is, the flashes from the lenses, instead of being single flashes, as usually exhibited at lighthouses, are each of them by the continual extinction and re-ignition of the gas broken up into four or five beams, which constitute a group of flashes recurring at regular intervals, thus presenting a very distinctive light for the guidance of mariners. This is accomplished by the same clockwork machine by which the lenses are caused to revolve. The interval between the group of flashes is one minute, the interval between the flashes composing each group is about two seconds, thus there are two seconds of light followed by two seconds of darkness, during which the gas is cut off; hence the economy.

One word more as to flashes. Just as the suddenness of the flash of a gun catches the eye, so the effect produced on fog when these large gas burners are suddenly lighted is very striking; and the use of gas as an intermittent light for lighthouse purposes is valuable, not only because of its economy (the intermissions, as I have said, being due to the cutting off and consequent saving of the gas), but also because of its illuminating effect on fog by the sudden exhibition of its great light.

Since the completion of Galley Head Lighthouse, the Commissioners of Irish Lights received from the commanders of the great ocean steamers which pass Galley Head the most satisfactory testimonials as to its power and distinctiveness. I will only quote one of many testimonials. Capt. Glendall calls it "a most powerful, strongly marked, and appropriate light, and of great service to shipping navigating that part of the Irish coast, it being so readily distinguished from all others in its vicinity."

Dr. Tyndall visited it and reported supposing its group flashing apparatus dispensed with, that it would be a revolving light, "surpassing any other in the world." Its burner is of 68-flame size, but were the power of the burner reduced to 48-flame instead of 68-flame, "the light with its full strength evoked would still transcend all other revolving lights."

Ex-focal Light.

Before leaving this part of the subject, I may be permitted to say a few words respecting one of the most important advantages of gas used in the manner I have just described for lighthouses. This advantage consists in the great amount of ex-focal light which is transmitted by the ordinary lenticular apparatus, owing to the large size of the gas flame. At the last meeting of the British Association, I introduced this subject, and quoted striking testimony, from seamen and other persons qualified to judge, to the effect that, by means of this ex-focal light, a mariner is enabled in foggy weather to see the position of a lighthouse which, unassisted by the ex-focal light, would not be visible. Time will not permit me now to repeat this evidence, which, however, is easily obtained, it having been printed for circulation; but the cause of that good effect is obvious.

You will observe that the gas burners have, to a greater extent than the oil lamp, what are termed tails of light, reaching up into the overhanging flue; these tails are, of course, ex-focal, and a considerable amount of their light is directed towards the sea, and thus illuminates it at the base of the lighthouse. The effect of the upper prisms, at which we have been looking, is to throw the light from these tails upwards towards the sky, as shown in diagram. While it is useful to throw down light so as to illuminate the sea at the base of the lighthouse, it is, I venture to say—notwithstanding the opinion of some opticians—still more useful to direct light towards the sky in order to illuminate the mists and fogs, more or less dense, which frequently hang over the headlands and islands upon which our lighthouses are built. The effect of the top and bottom prisms is, however, feeble compared with that of the central belt, and for this reason—as you have already noticed in the case of Galley Head—I would discard their use altogether for great sea lights in which gas is used. In looking at these diagrams, it may be well for me to remind you that the light represented by the lines shown in them is not of the nature of ordinary diffused light—such as proceeds from naked flames, which follows the law of diminution according to the square of the distance—but is directed light, and follows a definite path, with but little diffusion; and this applies as much to the light which is ex-focal as to that which is focal.

Now, as to the effect of the fog powers of the gas light. Looking at the diagrams on the wall, it must be plain that as the gas flames are enlarged in diameter, there will be ex-focal light from that increased diameter (and still more from the greater heights of the flames), but it is also evident that there will be also very greatly increased intensity in the focal light, due to the increased depth of the flame. Surely there must be a great deal more strictly focal light given by the 108-jet burner, 2,903 candles, than by the 4-wick oil lamp, 328 candles? and surely it is plain that this increase of focal light arises from the portion of the flame which is ex-focal? yet, strange to say, these facts have been disputed.

The advantages I have pointed out as possessed by large gas flames over flames of the ordinary focal size, are to be found in revolving lights and flashing lights, as well as in fixed lights. I do not, however, propose to occupy your time in considering that branch of the subject, further than to say that these large flames are applicable to the dioptric apparatus of first-order lights of every kind, and, indeed, to any order of dioptric apparatus down to the sixth or smallest.

Useful as are the results of ex-focal light in the cases of which we have been speaking, its advantages are still more manifest in the triform and quadriform lights. For the reasons before given, in this form of light, I discard the upper and lower prisms, and only use the central refracting belts, or the annular lenses, of which we have been speaking. Another diagram shows that the rays from the middle burner pass beyond their own lens to the upper and lower lenses, and are directed upwards and downwards, illuminating in their passage any mists they may encounter; and not only is it from the middle burner that this takes place, but the top and bottom burners also transmit their light through their own, and through the middle lens, so that, besides the direct focal beam of the three combined lenses, there is a halo of of ex-focal light all around them, of such large size as to be exceedingly helpful to the mariner in thick weather. I was interested, when visiting the recent Exhibition in Paris, to find that Messrs. Sautter, Lemonier, & Co., the well known optical engineers, are constructing for the Russian Government, lenses, for the express purpose of throwing beams of light into the sky, to enable seamen to know the position of a lighthouse from which they were separated by a headland. It is evident that the Russian authorities do not agree with the engineers in this country, who have maintained that beams of light which do not directly reach the eye are of no value to the mariner, and in this connection I may mention that I have recently devised an entirely new plan of horizontal and skyward flashing lights, which I hope may be of great use to the mariner; I intend very soon officially to make known its details.

ELECTRIC LIGHT.

The dimensions of the usual lanterns and dioptric apparatus of lighthouses not permitting us to use gas lights of a larger size than that which I have just described, it seemed desirable to consider whether we could not usefully add still greater intensity to our lighthouse gas flames than that obtainable from gas only. All our intense lights, such as the lime light, the electric light, magnesium light, &c. are costly; but it occured to me that, if I could add some such intense light to my large gas burners, so arranged that it need not be used except in thick weather, I would, at comparatively small expense, produce a fog-light, combining both quantity and great intensity. I made many experiments, and at length arranged for what I termed a core for my gas burners. Any of the intense lights I have mentioned might form this core. I first used, as the simplest and least expensive, a rich hydro-carbon flame intensified by oxygen, such as I may, in passing, show you in this lightship lamp, that you may see its effect in increasing the intensity of the flame. I tried the electric light also for this purpose, because of its great intensity, and because of the facility with which, owing to the recent improvements in dynamo-electric machines, it can be applied. The light from carbon points regulated by a Serrin or Siemens lamp is quite available for the purpose. By a simple alteration in the arms which hold the carbons, and of the clockwork by which those arms are moved, we can bring the light into the precise focus of the gas-burner, and apply it at pleasure. By means of a gas-engine, which of course can be used at all gas stations, this can be done in a moment. I have read small print at Salthill by the light transmitted from these combined lights at Howth Bailey Lighthouse, almost six miles distant, a test of the power of a lighthouse light more severe than has ever before been applied, so far as I am aware. But powerful as this combination is, my experience of the behaviour of the electric light in foggy weather is such as to prevent my proceeding further with experiments in that direction. At the last meeting of the British Association, I had the opportunity of laying the result of my observations before that scientific body. Briefly summed up, it is this—that while the electric light is much more intense than gas-light, there is a double objection to its use at lighthouses. 1stly. That in clear weather it is misleading to the sailor, he cannot be certain of his distance from it. In some states of the atmosphere it looks equally bright whether it be ten miles off or only one; and 2ndly, in foggy weather, when a light is specially needed, it is more easily totally obscured by fog than the large gas lights, combining quantity with intensity, which are now used for lighthouses, and which have again and again been seen in fogs in which the electric light has been quite invisible. The opinion of many scientific men has been adduced to this effect, and the evidence is so strong, that it seems to me that the conclusion is inevitable that the electric light is not well adapted for lighthouses. Would it not be wise, in the interests of the maritime public, that this question should be thoroughly investigated, with the view of ascertaining whether it is right that this light should be used any longer at lighthouses.

BEACONS.

When it is desired to establish and maintain lights upon beacons where space is limited, and to which access by boat is difficult or expensive, gas properly dried by chloride of calcium may be very conveniently applied as the means of illumination. A gas station on shore will command any desired number of beacons, and the lights may be simultaneously lighted and extinguished from the shore. The plan I have adopted, and exhibited in operation to the Commissioners of Irish Lights, is very simple; during the day time the gas is supplied at a pressure, say, equal to a column of water 6 inches high, to maintain a small light about the size of a pea in the lantern of each beacon. The gas for this light is driven through a by-pass in the valve of an automatic gas governor of suitable size fixed on each burner, and the high pressure at which the gas is supplied, prevents wind, or any slight movement of the supply pipe, from causing the extinction of the small flame which thus remains as the permanent lamplighter of the beacon. At night-fall, when the time arrlves for exhibiting the light in the beacon, the pressure at the shore station is diminished from 6 inches to, say, 1 inch, and this reduction in pressure immediately acts upon the governors which are attached to each light, causing their valves to open and thus admit gas for a full-sized flame. When the beacon light requires to be extinguished, the reverse process is gone through, the pressure on shore is increased, the governor valve rises and extinguishes the light, leaving, however, the small by-pass pea-sized flame ready for the performance of its function as lamplighter on the next occasion. The little apparatus I have here will clearly illustrate this method of illuminating beacons. I will put it into action. You will see that to light and extinguish the light at the opposite side of the room, I simply reverse the ordinary plan to which we are accustomed. I turn *off* this cock to cause the lights to spring up, and I turn it *on* to extinguish the light.

ATMOSPHERIC GAS.

At certain lighthouse stations there is hardly room for ordinary coal gas apparatus, although there are very few where space is so limited; but in cases like the Eddystone, Bell Rock, Fastnet, and others, an "atmospheric" gas machine is available. I do not now intend to enter into the merits of air gas for illuminating purposes as compared with ordinary coal gas. Much has been already written on the subject; nor is gas of this kind any novelty; it is nearly as old as the century in which we are living: I merely wish to submit that it is in a peculiar manner suitable for such purposes as the illuminating of rock lighthouses where coal gas is difficult of application. I may, perhaps, be permitted to remind you that air gas is not explosive, except in the same way that coal gas is explosive. This has been abundantly proved by its application without any accident whatever in many hundred cases to the ordinary illumination of country houses, and by the numerous experiments which have been made in attempting, without success, to explode mixtures of any proportion of hydro-carbon vapour and air burned under ordinary pressure. That air can be so charged with carbonaceous vapour as to form an illuminating gas of constant illuminating power, the operation of the apparatus which I have here would clearly prove. As in all air-gas machines, a current of air is impregnated with the vapour of such volatile liquids as may be employed for the purpose. I prefer a volatile product of Young's paraffin, but the peculiarity of this apparatus consists in the manner in which atmospheric air is saturated.

The principle upon which this part of the apparatus is constructed, is similar to that of the ingenious water-heater of Mr. Maughan. You are aware that, by one of these useful water-heaters, we can, in less than a minute, make a stream of cold water so hot as to be unbearable to the hand. This rapid change is effected by means of coils of wire, upon and within which drops of water are so finely divided, as to be immediately vaporised by the heat of the gas flame. This is a coiled wire, such as is used in the apparatus. I apply the same principle to my gas machine; just as water finely divided is quickly heated by the hot vapour of lighted gas, so does the hydro-carbon vapour of the liquid in the gas machine, when finely divided, quickly and thoroughly saturate the air with which it is brought in contact. A cylinder made of spiral wires, is caused to revolve by the same weight which drives the air-blower, and by which a constant pressure is maintained. One half the cylinder is submerged in the volatile liquid contained in the lower part of the apparatus, and the result is gas of high illuminating power. An atmospheric gas-machine of small size is on the table.

The cost of this gas is about the same as that of ordinary coal gas, but its advantage over home-made coal gas is the simplicity of the apparatus by which it is produced, requiring neither fire, nor retorts, nor gas-holders, but little attendance (say a few minutes per day), and no special knowledge on the part of any person in charge of it. Gas of this kind has also this very great advantage, that the products are as harmless as those evolved from the purest wax, and cannot tarnish the silver plating of reflectors, or injure other things, upon which the products of coal gas sometimes act detrimentally.

GAS GUNS AS FOG SIGNALS.

The great importance to navigation of audible fog signals is now universally admitted. Amongst those which have been suggested are gas guns. Some years ago, when I was engaged for the Commissioners of Irish Lights in fixing gas-making apparatus at several of their lighthouses, in order that gas might be used instead of oil, as the illuminant, it occurred to me that it would be convenient to use the gas available at such lighthouses for gas guns, as fog signals. With the sanction of the Commissioners I fixed gas guns of various sizes at Howth Bailey Lighthouse, and Dr. Tyndall and other gentlemen connected with the Board of Trade experimented with them. The noise of the gas gun is caused by the explosion of a mixture of oxygen and coal gas. We are all familiar with such explosions in the lecture room, but gas guns capable of producing a noise loud enough for a fog signal have only been tried, so far as I am aware, at Howth Bailey Lighthouse.

This mode of fog signalling has a very important advantage, viz., the gun may be fixed at the water's edge, or on a rock in the sea, at a considerable distance from a lighthouse or fog-signal station, and can be loaded and fired as often as required from the station without necessitating the lightkeepers leaving their post, the noise of the explosion and the flash (in itself a good fog-signal) being all the while at the point of danger. It is easy to imagine that such a point, say an isolated rock, might be too small to hold an ordinary gun, and be so inaccessible from the lighthouse, as to render the attendance of a gunner almost impossible.

In order to show how these guns are used, I have fixed one of small size in the far corner of the room, which, for the occasion, we may call an outlying rock, and connected it by an iron tube with this lecture table, which we may call a lighthouse on shore. This gasholder contains the charge, which, of course, is gaseous, and not solid as in the case of an ordinary gun. So soon as I have loaded the gun—which you will see that I do by simply opening a cock—I apply a light here at the shore end of the tube, by percussion cap or otherwise, and the gun at sea is fired. It will be seen that the explosion very quickly follows the application of the light, so that these guns may be fired at a great distance from a lighthouse or fog-signal station: a gas gun might thus be half a mile long. If the shots are required to succeed each other rapidly, any number of charges may be got ready and successively used. I will now fire the gun which I have loaded.

The gun which you have heard, being simply a piece of tubing, two inches bore by six feet long, has but a feeble sound. The experimental gas guns at Howth Bailey are tubes about eighteen inches bore by nine feet long, and are, as you may well suppose, of enormously greater power. The sound of the Baily gas gun is about equal to that of an eighteen-pounder cannon, and the cost of each shot of gas is about the same as that of each charge of gunpowder for the cannon.

GAS SIREN.

One of the most important fog signals with which we are acquainted, if not the most important, is the American Siren. It has been well described by Dr. Tyndall, Sir William Thomson, and Sir Richard Collinson, and I only refer to it for the purpose of pointing out that the value of that useful instrument is much increased by its being driven by gas. With gas, at a lighthouse, we are able to set up a most convenient motive-power, requiring neither furnace, boiler, nor stoker, and capable of instant application. The gas engine is by far the best means of driving a siren, chiefly because it may be put into motion in a moment, by the mere application of a match. The advantage of this instantaneous evocation of power can hardly be over-estimated in these days of rapid steam navigation. It is of the utmost importance that, in foggy weather, we should be able to put a powerful sound-signal into full blast at a moment's notice, and this is what can be done with the gas-driven siren. Shipwrecks may take place while we are waiting for the heating of steam boilers, or hot-air engines; and if, as I believe is sometimes done, the furnaces are kept always alight, great waste of fuel is of course involved.

One of these gas sirens has been in operation for some years at Howth Bailey Lighthouse. As an example of the efficiency of this plan of working it, I may mention that on one occasion last year it was sounded for 56 consecutive hours.* The siren at that important station has given great satisfaction to sailors passing near it in fogs, but I may add intense disgust to the residents on the Kingstown shore, six miles distant, where its unceasing wail is not conducive to sound slumber. Right-minded people, however, rather enjoy this discomfort for the sake of the mariner. There are, I am confident, some such philanthrophists in the world, and among them, I have no doubt, are included the audience whom I have now had the pleasure of addressing.

CONCLUSION.

In conclusion, I would say that these gas fog-signals are important accessories to the gas system, rendering it more complete and lessening its expense, but it is respecting gas as an *illuminant* for lighthouses that we are more immediately concerned this evening, and it is to that subject that the principal part of this paper has been devoted. I believe, and have endeavoured to prove that gas compares favourably with any other illuminant which has been introduced, having besides its greater illuminating power and moderate cost, "a flexibility, handiness, distinctiveness, and power of variability to meet the changes of the weather," by which it will maintain its superiority over the present oil system. These are not my words, they are those of the highest living authority on lighthouse lights, and as he has again and again, after most painstaking investigations, pronounced in favour of gas, and as his opinions have been corroborated by other thoroughly competent scientific persons (Sir William Thomson, F.R.S., Sir Richard Collinson, Sir Leopold McClintock, F.R.S., &c.), and borne out by the unanimous testimony of sailors navigating the seas where gas is used, it seems only reasonable, as the safety, nay the lives of mariners, are at stake, to say nothing of the incalculable amount of property which they carry for us in their ships, that *all* our sailors in *all* our seas should have the advantages which gas-lighted lighthouses can give them.

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* The great advantage which I claim for this method of working the siren, above all other forms of the instrument with which I am acquainted, consists in this, that from the compactness and simplicity of the arrangements by which it is driven, and from the fact that it is not necessary it should be united, by belt or otherwise, with any motive power, it can be sounded at the water's edge or on outlying rock, or at any position far distant from the station at which the steam boiler or compressed air receiver is situated.

APPENDIX.

Memorandum of Annual Costs of Gas and Oil (from Parliamentary Paper).

No. 1.—Paraffin Oil.

	£	s.	d.
Six-wick lamp, burning three outer wicks only, costs 8s. 8d. per night, for 305 nights (clear weather), say	132	5	0
Six-wick lamp at full power (foggy weather) costs 11s. 10d. per night, for 60 nights, say	35	12	0
Total per annum ......£	167	17	0

Maximum illuminating power, 722 candles.

No. 2.—Triform Gas Light.

	£	s.	d.
One 28-jet burner costs 6s. 8½d. per night, for 305 nights, say	102	6	0
Three 28-jet burners cost £1 0s. 2d. per night, for 60 nights, say..............	60	10	0
Total per annum ......£	126	16	0

Maximum illuminating power, 1,288 candles.

Cost of paraffin greater than gas by £5 1s.

Illuminating power of gas greater than that of paraffin by 566 candles.

No. 3.—Also Triform Light.

	£	s.	d.
One 28-jet burner for 305 nights........	102	6	0
Three 48-jet burners cost £1 16s. 8d. per night for 60 nights, say..............	110	0	0
Total per annum ......£	212	6	0

Maximum illuminating power, 2,496 candles.

Cost of paraffin less than gas by £44 9s.

Illuminating power of gas greater than that of paraffin by 1,774 candles.

Note.—These figures as to paraffin are taken from the Trinity House Table, Parliamentary Paper C. 1,151, 1875, page 64, but in this calculation the price of paraffin is reduced to that now paid by the Commissioners of Irish Lights, and instead of taking one-half for the consumption of paraffin in clear weather, the actual consumption of the three outside wicks is taken, as it is the three inside wicks which are turned down in clear weather. The consumption of the three outside wicks is much more than half, they being so much greater in circumference. The figures as to gas are also taken from same Parliamentary Paper, page 44. Particulars of burners are as under :—

Single Gas Burner.

Nature of burner.	Illuminating power of candles.	Candlepower per cubic foot of gas burnt.	Consumption per hour in cubic feet.	Cost per hour.	Cost per night (12 hours).
				s. d.	£ s. d.
28-jet ...	429·6	8·35	51·4	0 6.73	0 6 8·3
48-jet ...	832	9·34	93·2	1 0·2	0 12 3
68-jet ...	1,253·18	8·56	146·3	1 7·3	0 19 3·6
88-jet ..	2,408	9·87	244	2 8·2	1 12 2·2
108-jet ...	2,923·4	9·49	308	3 4·6	2 0 7·8

Triform Gas Burners.

Nature of burner.	Illuminating power in candles.	Consumption per hour in cubic feet.	Cost per hour.	Cost per night (12 hours).
			s. d.	£ s. d.
28-jet	1,288	154	1 8·3	1 0 2
48-jet	2,496	279	3 0·8	1 16 8
68-jet	3,759	439	4 10	2 17 11
88-jet	7,224	732	8 0·6	4 16 7
108-jet	8,770	924	10 2	6 1 11

Table showing the Comparative Annual Cost of Paraffin and Gas, taking into account the Maximum Illuminating Power in each case.

Annual cost of producing an illuminating power of 100 candles :—

	£	s.	d.
With six-wick paraffin lamp burning three wicks for 305 nights, and six wicks (full power) for 60 nights	23	5	0
With triform gas, 28-jet burner for 305 nights, and two other 28-jet burners for 60 nights	12	12	9
With triform gas, 28-jet burner for 305 nights, and 3·48-jet burners for 60 nights	8	10	1
With triform gas, 28-jet burner for 305 nights, and 3·68-jet burners for 60 nights	7	6	9
With triform gas, 28-jet burner for 305 nights, and 3·88-jet burners for 60 nights	5	8	6
With triform gas, 28-jet burner for 305 nights, and 3·108-jet burners for 60 nights	5	6	8

Or reduced to a unit of *one* candle power.

Annual cost of producing an illuminating power of *one* candle :—

	£	s.	d.
With paraffin burned as above..........	0	4	8
With triform gas as above, 28-jet burner	0	2	6
,, ,, 48-jet ,,	0	1	8
,, ,, 68-jet ,,	0	1	5
,, ,, 88-jet ,,	0	1	1
,, ,, 108-jet ,,	0	1	0

DISCUSSION.

The CHAIRMAN said this was a subject in which he had taken great interest for some years, and he must say that the deviser of the gas system of illumination for lighthouses had that evening given a most striking proof of his energy and ability. He had dwelt upon the handiness and flexibility, or, as Sir William Thomson called it, the plasticity of gas, which was a very important point; for, as every one connected with seafaring matters knew, at the present time, when lights were being so multiplied, it was very essential to be able to distinguish one light from another; and gas lent itself to this very readily, if not better than any other possible system. Mr. Wigham began by attacking the problem as to the best form of burner, and the maximum amount of light to be got from burners, and adopted a form which he supposed to be the best; then he went on in a manner which was highly ingenious from small burners consisting of 28 jets, about equal to a 4-wick lamp (indeed, it was said on the diagram to be superior, being 429 candles as compared with 328, but he doubted whether that represented the most improved form of Trinity 4-wick lamp), from that he advanced to 48 jets, and then, by successive steps, to 68, 88, and 108. He had seen these lamps shining in various places on the coast, and they had given him great delight, being the most powerful flames he had seen. Happily, through healthy competition, the oil system was receiving great development in this country, and by and by, probably Mr. Wigham would have a hard conflict with oil lamps. He would be put on his mettle to prove whether his burners were superior to oil in its latest stage of development. There could, however, be no doubt that he had produced not only burners of unparalleled power, but at the same time of unparalleled pliancy and capability to confer distinctiveness on lighthouse lights. He had gone still further, and carried out what he believed was substantially his invention, of superposing the central belts of the lenses one over the other, so as to multiply the light to an extraordinary extent. He had had the pleasure of seeing the Galley Head light, and he did not think there could be two opinions about it, that it was the finest flame light which had yet been established, either in this or any other country. On the whole, the public, and mariners especially, had reason to congratulate themselves that a fresh mind had struck into this subject, which would have a good effect in two ways; first by contributing these splendid lights, and in another way by stimulating those in favour of oil to push their experiments to the utmost.

Mr. J. B. REDMAN said the author of the paper had given a most graphic description of the various improvements in lighthouse illumination, and he took it that no man living had done more in the application of gas to this purpose. In 1843, he (Mr. Redman) published a pamphlet on the lighthouse system of Great Britain, in which he was then obliged to say with reference to gas, "Coal gas, from the large quantity of fuel required for its production, and the consequent cost of its transport, and also the uncertainty entertained as to the safety of the light, had not been adopted except in a few harbour lights, and even then, in some cases, it has been abandoned." In 1877, however, when lecturing to a class of students in military engineering at Chatham, he was able to refer to Mr. Wigham's gas apparatus at Wicklow Head Lighthouse, as equal to five different degrees of power, and saying that it was so arranged that an ordinary oil lamp could be substituted for it in a moment, showing that even at that time the safety of gas as an illuminant was not thoroughly recognised. But since 1863, at the Howth Bailey Lighthouse, where gas was first used, such substitution had never been required. It was also shown that the results were higher than from oil, prior to Mr. Douglass's recent improvements, which possibly the Chairman had referred to. Mr. Douglass had now produced oil lamps with concentric rings, which would burn mineral or vegetable oil, and from which he got a very high illuminating power. There was also the American Doty lamp, which was similar in principle. The triform arrangement had been found at first to give only twice the illuminating power, with three times the consumption of gas, owing to the loss of light at top and bottom, but he believed that had been satisfactorily got over. It occurred to him that the very beautiful lamps of Mr. Siemens might be applied to the lanterns of lighthouses.

The SECRETARY (Mr. H. Trueman Wood) said he could not pretend to any practical knowledge of lighthouse apparatus, but some time ago, in connection with investigations at the Patent-office, he had had occasion to become acquainted with the principles of lighthouse illumination, and he might perhaps offer a remark or two which might have the effect of eliciting some further information from Mr. Wigham. In the great battle which was now going on between gas and electricity there were few fields of more importance than this of lighthouse illumination, and any information on the subject would be most useful. There must of course be many places where nothing but oil could be used, and he supposed even Mr. Wigham would admit that where the very greatest light was required they would have to rely on the electric light; but in the great majority of cases the field was fairly open for gas or oil, and any further information on the comparative advantages of these two illuminants would be of great service. He would ask whether there was really any great saving by using gas where the dioptric system was adopted, because it was tolerably certain that with a good dioptric system there was no loss of light at all; it was all concentrated into those parts of the horizon on which the flash came, the light which would fall on the dark parts being turned aside and added to the illumination where it was required. This being so, and all the light which was produced being utilised, he did not quite see where the saving was to come from, unless it were that a much simpler apparatus could be used, which would lead to a saving in the initial cost of the apparatus itself. If they were ever to have anything like the system advocated by Sir William Thomson in a paper read last year, by which each lighthouse would flash out its own name, there were obvious advantages in the use of an illuminant which could be turned up and down, and caused to give flashes of any length or character which might be required, instead of a costly apparatus such as was required when it alone was relied upon for giving flashes of different lengths. With regard to the comparative penetrating powers of gas and electricity in fogs, it was pretty well admitted that in a thick London fog, electricity had very little chance with gas. The yellow rays of the gas passed much more readily through the yellow fog than the more refrangible rays of the electric light; but was this the case with the whiter fogs which prevailed at sea? He did not like to say much about the vexed question of ex-focal light, but to an outsider it seemed rather strange that engineers should devote all their powers to concentrating all the light they possibly could into a very small arc—the arc subtended by a line drawn from the horizon to a point comparatively near the base of a lighthouse of considerable height was not more than 17 minutes—and yet be grateful that some of it escaped from the apparatus, and was distributed to the ground and the sky. If that were really wanted, would it not be better to construct the apparatus so that some of the light would be purposely directed to those points, and not to trust to chance for such rays as escaped and were scattered abroad, where, no doubt, they had their use, but where they were much less required than on the sea itself.

Mr. LIGGINS remarked that now that our ships had so greatly increased in size, and the duration of voyages was so much accelerated, while greater punctuality was insisted on by passengers, it became of more importance than ever that the mariner should be guided to a safe destination by the most perfect light that the knowledge of the present day could devise. He had never listened to a paper with more satisfaction than the present one. He had not happened to be on the Irish coast for some years, and, therefore, had not seen the lights referred to; but until now he had been of opinion, from some observations, that the most perfect lights on our coast were the two on the South Foreland. He crossed not long ago from France, on rather a misty day, as it was getting towards dusk, and he was struck with the extreme penetrative power of those two magnificent lights; and on looking back towards France, he saw at Cape Grisnez a similar specimen of the penetrative power of the electric light. But he confessed after to-night's exhibition he should go away satisfied that he had still much to learn with regard to lighthouses and lightships. He should like to ask, however, whether the great concentration of gas lights in so small a space would not produce so much heat as rapidly to destroy the burners, because if a burner or two were to give way each night, it would disarrange the light, and cause irregularity? Of course this was a matter of detail, which might be got over by experiment. He was quite sure from what he had heard that this matter was as yet in its infancy.

Mr. WIGHAM, in reply, said the figures as to the power of the oil lamps were taken from trials of the Haisborough lamps, which were then considered the improved Trinity-house lamps; and they were certainly a great improvement on those which had been used for many years before. There may have been subsequent improvements, and he believed there had, and that still greater improvements were in contemplation, but those were the Haisborough lamps about which a Parliamentary paper had been issued, containing the figures as he had given them. As to oil lamps being made to beat gas, he should enter into the fight with the greatest possible pleasure, because he was perfectly satisfied that if an oil light were made to-morrow, having all the power and all the advantages which gas lights had, a gas light would be made to beat it next day. He saw so much capacity of development in the future of gas, that he did not think the battle could be left long in dispute. It was quite true, as Mr. Redman stated, that when gas was first used in lighthouses, engineers were so timid about it, that before they allowed it to be applied they required that, at a moment's notice, the gas burner should be replaced by an oil lamp. That was rather a difficult thing to do, because of the adjustment of the oil lamp in its exact focal place, and because the time occupied in screwing the joints on and off was likely to be very considerable; but a plan was devised similar to that by which the gas-light was increased, the oil lamp being made to drop into a cup of mercury, so that the oil would flow up immediately, without any screwing or adjustment. But so certain and continuous had been the supply of gas from that day to this, that it had never been applied. Reference had been made to the loss of light from the top and bottom prisms; and it had been estimated that the light from these prisms was equal to 30 per cent. of that from the whole apparatus. He had often tried the experiment of shutting off the top and bottom, or shutting out the middle, and looking at the light from a distance, and it did not appear to him that the proportion was so great; but even if it were, he thought it was better to have three times 70, *i.e.*, 210, than 100; and for that reason he devised the triform light, cutting off the top and bottom altogether. The Siemens burners were certainly very beautiful, and he had been much attracted by them. They would form very suitable burners for lighthouses, only that he did not quite see that they were capable of being increased in power to meet the various states of the atmosphere. The products of combustion were drawn down a central tube, and he did not see how the power could be adjusted, at any rate so easily as in a burner which had not this central flue. Again, a considerable portion of the light was sucked down this central tube, and of course lost for all illuminating purposes, though it might be compensated for by greater intensity in the rest of the flame. He also had a doubt whether for a lenticular light, which required a focus, it was not better to have that focus in a flame than to have a solid cylinder as in the Siemens lamp. He would not use the electric light at all for lighthouses, but he did not go at length into that subject, as it had been thoroughly treated at York by the British Association. The evidence was to the effect that whether it was from the colour of the light, or whether it were from the comparatively small point from which the light emanated, where it had been tried it had been found wanting, and after all, practical tests were the great thing in a matter of this kind. He had ventured to say in the paper that the Government should try the electric light against some of these gas lamps, or against the largest oil lamp they could get. If the electric light were better than gas, by all means use it, but he had great doubts about it. He recollected trying it very carefully on the clock tower at Westminster, the Commissioner of Works at that time being very anxious about it. He had a very powerful focal apparatus made by Messrs. Chance, in which there was an electric light fed by a large Gramme machine worked by a steam-engine in the basement, and it was compared with three 68-jet burners such as he had shown. When he was in Palace-yard, he thought he was completely beaten; the electric light lit up the whole yard, and the gas looked like a tallow candle; but when they went to Primrose-hill to judge of it, they found that when the weather got to a certain degree of density, the electric light got smaller and smaller until it went completely out, and the gas light still shone through. There were some fogs which put the gas light out also, but when the fog cleared away, the gas light shone out first, and a good while after the electric light came in view. So that, however superior the electric light might be for some purposes, for lighthouses and for penetrating fog he feared it was not the best. He did not quite know what saving Mr. Wood referred to in the dioptric system, but what he alluded to was the actual saving from the extinction of the gas. Sir William Thomson and the Morse system had been referred to; and he must say he had always had the greatest sympathy with his views about that—especially those views which he had recently modified. He had always thought it would be difficult to get sailors to go into the minutiæ of the Morse system; but at the same time, in advocating a system of flashing lights instead of fixed lights, because of their greater power, and that the flashes should be much more frequent—one minute, or even less, instead of two—his remarks were deserving of the greatest consideration. With regard to the ex-focal light, they ought to be very grateful to optical engineers who had taken so much pains to give as much focal light as possible; he would like the greatest possible amount of light in the focus; but he would also like some light out of the focus, and he believed in many cases it was more useful to have a large amount of ex-focal light, than to have a very intense focal light, because the focal light was confined to a very small limit; while the ex-focal light might have a very wide range, extending up into the thinner mists, above those which might possibly obscure the one direct beam. It was not, perhaps, necessary to say anything more about the electric lights at the South Foreland but he had heard complaints of their not always being visible in foggy weather; in some cases the lights on the Admiralty pier at Dover were visible, when they were not. Heat was not destructive to his burners at all. The top of the burner was a common fishtail, which cost, perhaps, ½d. and could be replaced very easily; and as to the lenses, great care was taken, before gas was allowed to be used, to prove that heat would have no injurious effect upon them.

The CHAIRMAN then proposed a vote of thanks to Mr. Wigham, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

PRODUCTION AND PREPARATION OF MALAGA RAISINS.

In a recent report by Consul Marston, of Malaga, there are some interesting details relating to the production and preparation of Malaga raisins. He states that in Andalusia there are two distinct vines, the Muscat and the Pero-Ximenez, the first indigenous, the second imported from the borders of the Rhine 200 or 250 years ago, by a German, whose name, corrupted in Andalusia, was given to the vine. Opinions differ as to the respective merits of these two vines. The cultivation of the vine is as follows:—The soil is dug out round the root, leaving a circular hole about one foot deep; and owing to the firmness of the soil, the operation is somewhat difficult. Manure of great strength is plentifully used by many proprietors. Different from Southern Italy, the vines here stretch themselves over the ground, and gather all atmospheric heat. Although white, the grape has a golden tint, and the skin is resisting and slightly tough. The branches appear like roots. The vintage is conducted with great care; all the fruit is not gathered at one time, but the same piece of ground is gone over three times, in order that the grapes may have the necessary ripeness. There are different methods of preparing the raisins—washing, drying by steam, and the simple drying in the sun.

The drying by steam is more particularly followed in the province of Denia, because of the insufficiency of solar heat. It is also employed in the south, in case the season is wet during the vintage. The cut grapes are put in baskets, and carried either on the backs of mules or donkeys, or in carts, to the places, often distant, where they are prepared, and although they transport the fruit with great care, it naturally suffers. The skin often breaks, which renders the drying difficult, if not impossible. To dry the grapes by the washing method, furnaces are constructed, of feeble draught, in which wood is used as fuel; a round kettle, varying in capacity from 300 to 400 litres, receives a lye formed from the residue or refuse of the grape after pressing. The lye used is either that obtained from the present year or that which has been kept from the previous vintage. Placed in wire colanders, with long handles, containing from two to three kilogrammes each, the raisins are plunged in this lye, boiling at a temperature of about 212° Fahr. After this first immersion, the workmen examine the skins to see if they are sufficiently shrivelled; if not, they immerse the grapes a second time, usually the last. This process of immersion is a very delicate one, and requires skilful watching and great judgment on the part of the workman who conducts it. According to the quality of the skin, the immersion should be more or less rapid, to save the grapes from bursting; much skill is also necessary to recognise the fissures which may appear. In cases where the heat has been too great, the raisins too rich in sugar will mould shortly after being packed. This process offers, among others, the inconvenience of exposing the raisins to fermentation during transportation, it necessitates expense for the construction of furnaces, besides the indispensable last drying in the sun; no matter what grapes employed, or what care bestowed upon the preparation, the results will always be relatively inferior. The method of preparing raisins by steam is as follows:—After having been exposed nearly twenty-four hours to the sun's rays, the grapes are carried on boards under cover to a building arranged with shelves, six or seven feet high. Heat is produced by steam that circulates, in an iron tube seven or eight inches in diameter, through the entire building. It is unnecessary to submit the grapes to a jet of steam, which would injure them by making them damp, but to a veritable heat of 160° Fahr.; valves arranged on the floor cause an even temperature. At the end of twenty-four hours the drying is usually finished; but as the immediate transfer from a temperature of 160° Fahr. to the open air would injure the ultimate result, it is necessary to let raisins cool gradually in a room constructed for the purpose, adjoining the heated room; and only when the raisins are entirely cool are they carried to the stores for packing. The following is the process generally employed in Malaga, a process the people are endeavouring to extend to other less favoured climates:—The sun furnishes all the heat required; it is sufficient to construct divisions of either brick or stone exposed to its rays in an inclined position, say ten yards long and two yards wide; the divisions or apartments are built up at one end with a sort of triangular masonry which, from a distance, gives them the appearance of a range of uniform tombs. The triangle is so constructed, that the sun never fails to shine upon the contents, the interior being covered with fine gravel which attracts the heat. Immediately after gathering, the grapes are placed in these divisions, and are exposed to the heat of the burning Andalusian sun. Experienced cultivators affirm that during the heat in August, they attain a temperature of 145° Fahrenheit. At nightfall a very simple method of covering is applied to guard the fruit from the heavy dews or rain, either composed of sail-cloth or heavy canvas, so arranged that it covers entirely the grapes that are drying within, and being supplied with rings on two sides, slides up and down like a curtain. In many places boards or planks are used, giving the appearance of a roof. During the process of drying, those grapes which remain green or are spoiled are carefully removed, and each grape is turned, in order to preserve an uniformity in the darkening of colour. Competent judges give the preference to this simple method of drying, as much for the results as for the simplicity of the process. The raisins that have been prepared by the scalding process dry in four days, while those dried by the sun take ten days, but this loss of time is largely compensated by the economy of expenditure. The raisins are not ready for packing immediately after being dried, but have to be kept several days in the stores on the planks on which they are carried. The raisins that are spoiled or defective are picked out, especially any that may be broken or bruised, out of which one drop of moisture would probably damage a whole box, and very great care has to be exercised in this picking out. Finally they are classified, which is an operation exceedingly difficult, as cultivators and merchants differ greatly in their opinions; the merchants nearly always remodel the boxes packed by the producers. The boxes are mostly made by contract, at a cost of about seven pence halfpenny each, the best being made of fir imported from Portugal. The producer almost always provides the boxes and packs them, but they are always repacked in the towns by the merchants, who usually employ women or girls for this work. All raisins are packed in boxes, except those shipped in barrels and frails, and are divided into four layers in each whole box, which, if of full size, contains 22 lbs. of fruit, the total weight, with the box, usually being 28 or 29 lbs. The crop of raisins produced in the Malaga district from the vintage of 1880 and 1881, is estimated at between 2,000,000 and 2,050,000 boxes. The stock of raisins at present in the province of Malaga is estimated at about 150,000 boxes, while one year ago it was estimated at only about 50,000 boxes.

Correspondence.

FOREST CONSERVANCY IN INDIA.

Colonel Pearson only paid the tribute due to his former chief, when he ascribed to Dr. Brandis, C.I.E., the credit of having reorganised the Forest Department in India as it now exists; but it was an error of omission on his part, although, I am sure, perfectly unintentional, leaving it to be inferred that Dr. Brandis was the first to introduce forest conservancy into India. The fact is, that ten years before 1857, the date of the first appointment of Dr. Brandis to the Indian Forest Department, the foundations on which he reconstructed it had been deeply laid in the Madras Presidency, where scientific forestry originated in India.

In 1847, Major-General Frederick Conyers Cotton, C.S.I., then a captain in the Madras engineers, in crossing the mountains which divide Coimbatore from Cochin, was struck by the wasteful manner in which the timber contractors for the supply of the dockyard at Bombay with teak, were working the forests, which they rented from the Collector of Coimbatore. He accordingly urged on the Government of Madras the advisability of taking them into their own hands, and working them through their own agents; and on his recommendation, Colonel (then Lieutenant) Michael, C.S.I., was appointed to carry out the experiment, at first under the direction of General Cotton, and afterwards of the collector of Coimbatore. Colonel Michael organised an establishment, opened out roads throughout the lower Annamully Hills, and timber slips down the mountain passes, and soon scored a financial success. It then at once became apparent that it was far more important, in the future interests of the Presidency, to conserve its magnificent natural forests, than secure a present revenue by supplying timber to the Bombay dockyard, and in 1848 the neighbouring forests of Colimgode were leased of the Zemindar, and all his minor contracts with timber contractors bought up, and the whole tract down to the Cochin and Travancore boundaries was placed, and has ever since remained under the strictest conservancy. A system of clearing the brushwood to preserve the young saplings from jungle-fires was introduced, the hill tribes being employed as much as possible in the work, to enlist them, in this way, on the side of conservancy; and thus the greater part of the forests of Southern India was saved.

Within a few years the advantages of these measures were so clearly shown, that the Court of Directors, in their despatch of 29th March, 1854, sanctioned their application to the other forests in the Madras Presideney, and in short, commenced the organisation of the regular Forest Department, the operations of which have since been extended all over India and British Burma.

About the same time Col. Michael, having completely undermined his health by seven years of incessant exposure to the dangers of forest life, was forced to retire from his appointment, and was succeeded in it by Surgeon-Major Hugh Cleghorn, M.D., who carried out the extension of the new department in Madras and the Panjab with astonishing vigour, and the most distinguished success. Subsequently, after the arrival of Dr. Brandis in India, Dr. Cleghorn most efficiently co-operated with him in introducing and systematically working conservancy in Bengal, with the admirable results which Col. Pearson has so ably stated in his interesting lecture.

Let me add that I do not seek to disparage in the slightest degree the services which Dr. Brandis has rendered to forest conservancy in India. It would be impossible to exaggerate their value (see my Appendix D to my "Handbook to the British Indian Section, Paris Universal Exhibition of 1878"); but he could never have accomplished his special work had not the foundation for it been previously laid by men like Michael and Cleghorn, Pearson in the Central Provinces, old "Daddy Gibson" in Bombay, and others of lesser note elsewhere. Dr. Brandis himself would be the last to despise the day of small things in Indian forestry, and the first to apply to its history, in view of the signal success of his own administration of the Forest Department, the Hindu proverb, "Small beginnings are auspicious." He has been the re-organiser--the Bonaparte of the Department—but let us never forget that General Cotton first conceived the idea of Government itself working the Madras forests, and that Michael was the pioneer of practical conservancy, and Cleghorn the father of scientific forestry in India. Col. Michael's share in the matter was particularly important, and most creditable to him. He was but a "griffin" when placed in charge of the Annamully forests, yet showed such energy, and achieved so marked a success in his novel work, as at once caused attention to be drawn to the condition of the Indian forests generally. This happened in the very "nick of time," for a few more years delay in introducing conservancy would have resulted inevitably in the total loss of half the forests of India. In Sir John and General Richard Strachey's recent work on "The Finances and Public Works of India," it is stated:—"The net forest revenue, which is almost entirely derived from the sale of timber and other forest produce, the property of Government, was £158,854 in 1869-70, and £223,000 in 1880-81, and it has only once exceeded £237,000, namely, in 1875-76, when it reached £274,551. The stationary condition of the net forest revenue has been rather a matter for satisfaction than otherwise. The forest administration, which is of comparatively recent creation, looks to the future interest of the community more than to present profit, and is more occupied in the preservation and improvement of the State forests, than in realising an immediate large revenue. The gross revenue is now, however, close on £700,000."

GEORGE BIRDWOOD.

General Notes.

ZINC PRODUCTION.—The total production of zinc in Europe attained 203,330 tons in 1880, of which Germany produced 99,405 tons, or nearly half, about two-thirds of which were extracted from Upper Silesia. After Germany comes Belgium with 65,010 tons, then England with 22,000 tons, France 13,715, and Austro-Hungary 3,200.

PILE DRIVING BY ELECTRICITY.—The piles to support a coffer dam across the River Lea in Lord Saalisbury's park at Hatfield, have just been successfully driven by the power from a water-wheel situated at a distance, which power was transmitted by two dynamo machines and a couple of wires to the gearing connected with a pile-driver of ordinary construction, erected on a barge floating in the river. The machinery, although rather roughly constructed, is reported to have worked well, lifting a dolly weighing from four to five hundredweight with ease and regularity.

BEER IN FRANCE.—It appears from the French Revenue returns that the production of strong beer in France has doubled during the fifty years ending with 1880, while that of small beer has increased sixfold. In 1830, the quantity of strong beer made was 2,416,470 hectolitres (53,162,340 gallons), and that small beer 564,152 hectolitres (12,411,344 gallons), giving a total of 2,980,622 hectolitres (65,573,684 gallons). In 1880, the quantity of strong beer was 4,936,759 hectolitres (108,608,698 gallons), and that of small beer 3,290,246 hectolitres (72,385,412 gallons), forming a total of 8,227,005 hectolitres (180,994,110 gallons). On the other hand, the quantity of foreign beer, of which English forms a large proportion, imported into France, amounted in 1830 to 1,663 hectolitres (36,586 gallons), and in 1880 to 378,752 hectolitres (8,332,544 gallons).

BELGIAN PRIZES.—It is decided that the £1,000 prize, offered annually by the King of the Belgians for a treatise on some step in social progress, shall be awarded in 1883 for the best work on the method of introducing into establishments of public instruction corporal exercises, with which the citizens of a free country should become familiar, and which are calculated to develop the manliness of the population. The competitions are, on alternate years, exclusively national, and open to all the world. Belgian subjects alone are entitled to compete for the prize of 1883. A third competition is opened in Belgium for Dr. Guinard's legacy of 10,000 francs (£400), to be adjudged to the best work, or the best invention, tending to improve the material and intellectual position of the working classes generally, and without distinction. The competing works are to be sent in to the Minister of the Interior before 1st July next.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

MARCH 22.—"The Tonic Sol-fa System." By J. SPENCER CURWEN, President of the Tonic Sol-fa College. The paper will be illustrated by experiments on a class of children from a London Board School.

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A. Dr. W. J. RUSSELL, F.R.S., will preside.

Meetings after Easter:—

"The Channel Tunnel." By Sir EDWARD WATKIN, Bart.

"The Constant Supply and Waste of Water." By GEORGE F. DEACON. Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, will preside.

"Telephonic Communication." By LIEUT.-COL. C. F. WEBBER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 21.—"The Condition and Characteristics of some of the Native Tribes of the Hudson Bay Company's Territories." By JOHN RAE, M.D., LL.D., F.R.S.

APRIL 25.—"The Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. NOEL SHORE, author of "The Flight of the Lapwing." Sir RUTHERFORD ALCOCK, K.C.B., will preside.

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock:—

MARCH 23.—"Some Practical Aspects of Recent Investigation in Nitrification." By R. WARINGTON, F.C.S. Dr. J. H. GILBERT, F.R.S., will preside.

APRIL 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS and PERCY C. GILCHRIST.

MAY 11.—"The Recovery of Sulphur from Alkali Waste by Schaffner's process, a record of recent results." By ALEXANDER M. CHANCE, of Birmingham.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

The meeting announced for March 17th is postponed.

APRIL 21.—"The Mineral Resources of India, and their Development." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

MAY 5.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE,

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Third Course will be on "Hydraulic Machinery," by Prof. JOHN PERRY.

LECTURE III.—MARCH 20.

Water-wheels and pressure-engines. Turbines. Measurement of the horse-power given out. Loss of power by friction. Hydraulic fittings, pipes, valves, &c. Accumulators, cranes, and hoists.

LECTURE IV.—MARCH 27.

Lifts. The new balance method, as applied in bridges, canal boat, and other lifts. The transmission of power to machines at a distance by means of water. Applications to various tools. Comparison of hydraulic and electrical methods, and the part which each is likely to play in the future.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. John Perry, "Hydraulic Machinery." (Lecture III.)

British Architects, 9, Conduit-street, W., 8 p.m. Resumed Discussion on "The Conduct of Architectural Competitions."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. 1. Dr. R. G. Latham, "The Date and the Personality of Priyadâsi." 2. Mr. Arthur Lillie, "Buddhist Saint-Worship."

Victoria Institute, 7, Adelphi-terrace, W.C. 8 p.m. Surgeon-General Gordon, "Climatic Influence as Regards Organic Life."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. R. Bentley, "Materials used for Paper."

Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. G. W. Hastings, "The Bills before Parliament for the Notification of Infectious Diseases."

TUESDAY, MARCH 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. John Rae, "Remarks on the Condition and Characteristics of some of the Native Tribes of the Hudson Bay Territories."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. G. McKendrick, "The Mechanism of the Senses." (Lecture X.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. Charles B. Bender's paper, "The Design of Structures to Resist Wind-Pressure." 2. Discussion on M. Jules Gaudard's paper, "The Resistance of Viaducts to Sudden Gusts of Wind."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. Robert Giffen, "The Use of Import and Export Statistics."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Anthropological Institution, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. A. L. Lewis, "The Relation of Stone Circles to Outlying Stones or Tumuli, or Neighbouring Hills." 2. Mr. J. E. Price and Mr. F. G. Hilton Price, "Excavations of Tumuli on the Brading Downs, Isle of Wight." 3. Major-General Pitt-Rivers, "Note on the Distribution and Varieties of a Padlock."

Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, MARCH 22....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Spencer Curwen, "The Tonic Sol-fa System." Illustrated by experiments on a class of children from one of the London Board Schools.

Royal College of Physicians, Pall Mall East, S.W., 5 p.m. (Croonian Lectures.) Sir Joseph Fayrer, "The Climate and Fevers of India." (Lecture III.)

Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, MARCH 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. R. Warington, "Some Practical Aspects of Recent Investigation in Nitrification."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Ernest Pauer, "The Sonata under Haydn and Mozart."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. W. Bradley, "The Meaning of Law in Decorative Art."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Tyndall, "Resemblance of Sound, Light, and Heat." (Lecture II.)

Royal National Lifeboat Institution, Mansion-house, E.C., 3 p.m. Annual Meeting. The Lord Mayor of London in the chair.

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

East India Association, 14, Bedford-row, W.C., 3 p.m. Mr. John Dacosta, "By Whom is India Governed."

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Prof. A. E. Dolbear, "The Development of a New Telephonic System."

FRIDAY, MARCH 24...Royal United Service Institute, Whitehall, 3 p.m. Captain Walter H. James, "Military Education and Training."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly meeting, 9 p.m., Prof. W. E. Ayrton, "Electric Railways."

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. J. Burdon Sanderson, "Pathology of Inflammation." (Lecture I.)

Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. E. T. Newton, "On Fishes' Tails."

Browning Society, University College, W.C., 8 p.m. Rev. J. Kirkman, "Child Roland to the Dark Tower came."

SATURDAY, MARCH 25...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. Shelford Bidwell, "Effect of Temperature on the Electrical Resistance of Mixtures of Sulphur and Carbon." 2. Mr. C. Vernon Boys, "Measurement of Curvature and Refractive Index."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof H. G. Seeley, "Volcanoes." (Lecture I.)

Journal of the Society of Arts.

No. 1,531. Vol. XXX.

FRIDAY, MARCH 24, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor John Perry delivered the third lecture of his course, on "Hydraulic Machinery," on Monday, 20th inst., which was chiefly devoted to the description of water-wheels, pressure engines, and turbines. The questions relating to the measurement of the horse-power given out, and the loss of power by friction, were considered, and the various forms of accumulators, cranes, and twists explained. Models of turbines were lent by Professor James Thomson and Messrs. G. Gilkes and Co., Kendal; models of water-power engine and Brotherhood engine, by Mr. Ellington (Hull Water-power Company); models of gauge notch, Barker's mill, &c., by the City and Guilds Institute Technical College; Transmission Dynamometer, by Messrs. Ayrton and Perry; hydraulic ram, by Messrs. Roe and Co.; and diagrams, by Mr. Tweddell, Mr. Ellington, and the Institute of Mechanical Engineers.

THE SOCIETY OF ARTS' PATENT BILL.

The Bill for the Amendment of the Patent Law, prepared by the Council of the Society of Arts, has been brought in by Sir John Lubbock, Mr. W. H. Smith, and Mr. J. C. Lawrance, Q.C. The second reading of the Bill is set down for Wednesday, April 5.

The following are some of the principal alterations which would be effected by this Bill:—

Novelty.

By one of the interpretation clauses it is provided that an invention is to be deemed new unless it has been published, or publicly used, within a period of thirty years preceding the date of the application for a patent for it. The object of this is to prevent the invalidation of a possibly useful invention by an old, and it may be incomplete, description of something like it. At present, an otherwise good patent might be overthrown on the ground that the invention had been anticipated by a description in an obsolete and unknown book, of which a single copy existed in the British Museum.

Subject-matter of Patents.

For the first time in any Act or Bill dealing with Patents, an attempt is made to define what is subject-matter for a patent. Under the present Act, the only definition is that contained in the Statute of James I., known as the Statute of Monopolies, namely, "any manner of new manufacture within this realm."

Commissioners of Patents.

The Bill provides for the appointment of a Board of Commissioners of Patents, to consist of an engineer, a chemist, and a lawyer. These Commissioners are to carry on the duties of the existing Commissioners, and certain other functions specially provided by the Bill.

Application for and Grant of a Patent.

An applicant for a patent would be required to lodge his application, as under the present law, accompanied by a provisional specification, and would receive provisional protection for his invention on such application. The provisional specification would then be referred by the Commissioners to an Examiner, who would report whether the invention was subject-matter for a patent, whether the title was sufficient, and whether the provisional specification was in accordance with the title. If the Examiner reported adversely, the application might, if the applicant persisted, be proceeded with, but in that case every copy of the patent would be endorsed with a statement of the Examiner's report. The next step on the part of the applicant would be the lodging of a complete or final specification, together with a written request for the sealing of the patent. This final specification would be examined in the same way as the provisional, to see if it agreed therewith, and also whether the nature and object of the invention were stated with sufficient clearness. No examination whatever as to the utility or novelty of the invention is contemplated. Provision is also made for cases in which the applicant prefers to file a complete specification in the first instance, without the preliminary step of filing a provisional. On the grant of the patent, the complete specification is to be published. If the application be not proceeded with, the provisional specification would be destroyed. The object of this is to prevent the incomplete description given in an abandoned provisional specification, from interfering with any future application for a patent for a similar invention.

DURATION OF PATENT. FEES.

The term of the patent is to be 17 years, subject to the payment of duties of £5 on the grant, £20 at the fourth year, £50 at the eighth year. The fee on application is set down at £2 10s. The total cost of a patent, in the first instant, would thus be £7 10s.; the fees for the full term would amount to £77 10s.

AMENDMENT.

Large powers of amendment are given under the Bill.

PROLONGATION.

Applications for prolongation would be made to the Board of Commissioners, not, as now, to the Privy Council. Prolongation could be granted for any period not exceeding 11 years. No conditions could be made in respect of an order for prolongation, and special instructions are given to the Commissioners as to the points which they would have to consider in granting or refusing it.

PATENT TO BIND CROWN.

As in some previous Bills, but not under the existing law, the patent is to have the same effect against the Queen as against a subject. Certain limitations with reference to naval and military service are provided.

COMPULSORY LICENSE.

In certain very special cases the Commissioners are permitted by the Bill to order a patentee to grant licenses.

DUTIES OF COMMISSIONERS.

The duties of Commissioners are stated at greater length than in the Act of 1852, or than in any previous Bills. It is specially laid down that they are to prepare indexes, abridgments, and such other works as they think proper; to keep open a museum and library free of charge, and to print and keep on sale copies of all specifications, &c

PATENT ACTIONS.

By a provision under this head, a defendant in a patent action is not allowed to set up as a defence that a part of the patent other than that stated to be infringed is invalid, and thereby the whole of the patent vitiated. The Commissioners are to act as assessors in patent actions when required by the Court, or patent actions may be referred by order of the Court, to the Commissioners instead of to an official referee; and further, it is to be the duty of the Commissioners to act as arbitrators whenever the parties to the action agree.

There are many other points of importance in the Bill, but it is believed that the above comprise those which would effect the greatest changes in the present practice.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefit of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, in the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S. "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L. F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

The Council invite members of the Society to forward to the Secretary, on or before the 22nd of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, March 21, 1882; B. Francis Cobb, Treasurer of the Society, in the chair.

The paper read was—

ON THE CONDITION AND CHARACTERISTICS OF SOME OF THE NATIVE TRIBES OF THE HUDSON'S BAY COMPANY'S TERRITORIES.

By John Rae, M.D., LL.D., F.R.S., &c.

In limiting my remarks to only a few of the native tribes of what are called the Hudson's Bay Company's Territories, I am actuated by two principal motives.

1st. Because I desire to speak only of those tribes of whom I have, more or less, some personal knowledge.

2nd. Were I to attempt to give even the most brief history of all the tribes that are to be found in this vast extent of country, not one, but at least half-a-dozen papers would be required for the purpose; and to look up authorities and give information derived from them, would not be an expression of my own views, but of theirs. It may be that, in the course of this paper, I shall have once or twice to step over the boundary-line of the territory I have prescribed, but this, if done at all, will be very briefly, and only for the sake of illustration.

The whole of the aborigines of British North America have for convenience of classification been divided into four races, which, beginning at the North, are as follows:—

1st. The Eskimos, Esquimaux (Innuit or Innok), stated to amount to about 4,000 persons, and living on the Arctic sea-board, from Behring Straits, with slight intermission to Labrador, a distance of about 5,000 miles.

2nd. The Dené-Dindjié, which embraces eleven tribes, east of the Rocky Mountains, from the Athabasca District to the Eskimo-lands on the confines of the Arctic Sea, numbering about 22,000 individuals, and occupying about one million square miles of country.

3rd. The Algonquins, comprehending twelve tribes, over a very large tract of country of irregular form, from near the shores of Labrador to the Rocky Mountains.

4th. The Hurons-Iroquois, found chiefly on the shores of Lake Huron and the Ottawa River, and in the province of Quebec.*

I further beg to remind those whom I have the honour of addressing, that my information is by no means of recent date, being from twenty-eight to forty-five years antecedent to the present time, so that the conditions of some of those tribes about whom I speak may have undergone a material change, either through the influence of the many zealous missionaries who have visited and been stationed among them since that time, or from other causes.

During a ten years' residence at Moose Factory, as surgeon, I had many and fair opportunities of studying the habits and character of the Crees of the woods, called also Maskeg, or swampy Crees. This tribe is estimated to number about 3,000, and is found all along Hudson's Bay, from East Main to Churchill, in the north-west, then westward to Norway-house, Lake Winnipeg. The same Indians are also said to inhabit the lands lying between Hudson's Bay and the Gulf of St. Lawrence. Of this fact I have no personal knowledge, but my authority is, I believe, to be perfectly relied upon, as he has seen them, and says that they very much resemble the Crees at Moose, and speak very nearly the same language.

At Moose, the word "No" is *numma-wila;* at Rupert's-house, *nummawia;* at Albany, *nummuwina;* and at the St. Lawrence Gulf, *numma*. At Moose, I have heard all or any o these words used for "No."

The Wood Crees, or "Swampies," are about the average height of Englishmen, or, perhaps, a little taller, but there is as much variety in this respect as among ourselves. They have a good capacity of chest, but are rather round than broad, are strong and active, being good walkers, and able to haul heavy sledges and carry heavy loads over the portages, being very capable voyageurs, both in boats and canoes. They are so trustworthy that they are often sent long voyages with valuable cargoes of goods or furs, having no white man with them, and deliver their charge at its destination safely, and usually in better condition than the cargoes sent under the management of the Company's regular servants.

The women cannot be said to be pretty, but they have a very pleasing manner and expression of face, and their soft agreeable voices make them, especially when young, by no means unattractive.

The clothing of both sexes, in times prior to the advent of the Hudson's Bay traders, must have been chiefly composed of reindeer skins and furs of various kinds, of which, no doubt, rabbit skins *(Lepus Americanus)* formed an important part. At the time of which I speak, the winter dress of a man consisted of a stout blanket coat, with a dark blue hood, one or two woven flannel shirts, leggings of strong blue, red, or white cloth, coming high up on the thigh, an assyan or breech cloth, large leather mitts, with blanket lining, and moccassins, having a fold or two of *duffle* inside. A cap of coarse fur is also sometimes worn. The coat is confined at the waist by a scarlet or striped worsted belt, long enough to pass with ease twice round the body. To this belt, on one side is suspended that most necessary and useful article, a fire bag, containing pipe and tobacco, flint and steel, box of brimstone matches, touchwood and tinder, and one or two other odds and ends. To balance this, on the other side, are the small trapping axe, useful, if not absolutely requisite, for many purposes, and a sheath knife. If on a hunting excursion, a powder horn is hung over one shoulder, and a pouch, with shot and ball, over the other, which, with a long single barrel flint gun of very small calibre, completes his equipment. If the man is to be absent a night or two, a blanket (all his bedding, however cold it may be), with a few pounds of dried meat or fish, and a tin pot, in which to thaw water for drinking, is added to the above very simple outfit. It may be asked, what about cooking? That is a very easy matter. The meat, fish, or whatever else it may be, is placed firmly on a pointed piece of stick, and stuck up before the fire, and thus speedily cooked, making what is called a "ponask," and a very pleasant supper it constitutes after a long day's march on snowshoes, about the finest exercise a man can take. The Indian, when travelling or hunting, eats very little breakfast, but a mighty big supper.

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* I am indebted to the kindness and courtesy of the Secretary of the High Commissioner of the Dominion Government in London, for the use of the volume from which I extract the greater part of the above information.—J. R.

The summer dress is very similar to that worn in winter, only the capot or coat is of thinner material, and of a grey or blue colour, a striped cotton shirt takes the place of a woollen one, and the big mittens are laid aside.

The women's dress is usually of blue cloth, long enough to come within six or eight inches of the ground, leggings ornamented with ribbon or coloured gartering, mocassins, and a cap made of a piece of cloth about 18 inches long, and the same in width, doubled and sewn up at one end. It is ornamented like the leggings, but a considerable amount of bead work is often added. This form of cap is very useful in preventing the snow from falling on the nape of the neck when walking among the snow-covered woods in winter; coloured cotton handkerchiefs and small shawls are also much worn. The hair is usually tied into a cue behind, in the most simple form.

The Cree women are not generally harshly treated by their husbands, but they have some very hard work to do in carrying heavy loads, and hauling sledges with the greater part of the baggage of the family, when changing camp. Their tents are made of reindeer skin, when the man is a good hunter, or rich enough to buy the necessary skins; when too poor to do so, they prepare long strips of birch bark about 18 inches wide, peeling it as thin as possible. These roll up very snugly, are by no means heavy, and form good shelter when properly placed round the tent poles.

The routine of a year's life of a wood Cree is very much as follows:—He, and probably his wife, come into the Fort, generally about the middle of April, with the furs obtained in the winter. These he either barters for goods, or, what is more likely, pays for an outfit he has received in the autumn on credit; and, if there is anything left over, purchases what he is most in need of.

I should here mention that all Indian hunting grounds are almost as well defined as the estate of an English gentleman; and if an Indian were to destroy a beaver house, and kill the beaver in it, on a neighbour's domain, he would be considered guilty of a very disreputable piece of poaching.

It has been the desire of the Hudson's Bay Company to carry on a ready-money barter with the natives, but the improvidence of the Indians has always frustrated the attempt. Debts have been cancelled over and over again with this object, to no purpose. If paid for their goods in the spring, the Indians squandered all they received before the end of the summer, and had to be supplied with a fresh stock of articles for their winter use. If his object is to shoot wild fowl, the man is supplied on credit with ammunition, and, about the end of April, proceeds to some favourite feeding place of geese and ducks on the coast, and there pitches his tent. Here, if a moderately good shot, he lives in comfort and abundance for four or five weeks, besides, perhaps, sending some hundreds of geese, with their feathers and quills, to the Fort, to be traded for ammunition.*

The manner of goose and duck shooting in these parts is very simple, yet requires considerable judgment. The Indian collects a large bundle of willows and grass, and approaches the wild fowl feeding grounds. He then sits down, and for a time, watches the direction of flight of the birds, which, in windy weather, and at certain times of tide, are very restless. Having selected a spot, usually near a pool of water, he makes an enclosure of the willows, large enough to sit comfortably inside of. The grass is used to sit upon, and also to mix with the willows that form the shelter, to make them as little conspicuous as possible; this is called a "stand." At the edge of the pool of water he sets up a number of pieces of hard mud, about the size, and something after the shape of geese, and sticks two or three white feathers in the upper part, to resemble the head and neck of the blue-winged goose, which is, of all other kinds, the most numerous in the marshes I allude to. Having loaded his guns (he usually has two), he keeps a sharp look out for game. On seeing some flying at a distance, he crouches down, and begins to imitate their call in a very perfect manner; the attention of the birds is attracted, and on seeing the decoys, they usually wheel round, and come up from leeward, either over or close to where the Indian lies concealed, and he generally secures one with each gun. If there are only two geese, a male and female, he invariably shoots at the female first, and if he kills her, he is pretty sure to shoot the gander also, as his affection for his mate is almost certain to bring him a second time within shot.

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* About 50,000 geese, besides many ducks, all of fine quality as food, are annually shot on the shores of Hudson's Bay. A goose, and pound of flour, is a man's daily ration.

The Indians all say that a small bird that always arrives about the same date as the Canada goose, uses this large and powerful bird as an easy and agreeable means of transport northward; and assert that they often see one or more fly away from a goose when it has been fired at. As nothing of the same kind is said about any of the other kinds of geese, I am inclined to believe the statement to be true.

By the time that the wild fowl have taken their second flight northward, the rivers are open enough for navigation, and those Indians that are strong and active, and willing to work, are engaged to form crews of boats going up the rivers with loads of goods for the inland posts, for which at that time they received much higher wages than are paid either in England or Ireland, with abundant rations. The work in ascending the stream is hard, especially on the portages, where the usual load is 180 lbs., and each of the crew has generally to carry four such loads over the portage. The descent of the river is much more easy, because the lading, consisting of furs, is much lighter; and the boats are coming down stream. In the summer, there are many other services to which the Indian is put. The squaws, during the absence of the men, are occupied either in setting nets, or angling in the river, when not engaged to do some work at the fort.

The autumn comes round, and with it, in September, appear the wild fowl on their southward migration, in much larger numbers, and many of them being young, much more easily shot than in spring. In this case the wily Indian sacrifices the mother to her affections. It is almost painful to witness the efforts made by the poor parent to induce her brood, of perhaps five or six young, to avoid the fatal attraction of the decoys and imitation call of the Indian, who crouches patiently, even although the young ones are flying quite close to him, until the mother comes within shot; when he shoots her, he is pretty sure to be able to kill the whole brood, as they will not leave the place where their guide and guardian fell. The papa generally keeps out of reach, having possibly had some bitter experience of the danger of going near the decoys, and his paternal affection not being equal to that shown in the spring for his partner.

The geese and ducks, in the fine feeding of the salt marshes, become very fat, so that the Indians save up a large quantity of grease and a number of geese, boned and dried for winter use. The grease is packed in bags, made of the skins of the geese themselves.

Warned by some sharp frosts and showers of snow, both Indians and wild-fowl start for winter quarters about the same time. The latter (especially the geese, which make very long flights without resting) prepare themselves by a few days' fasting, as is evinced by their not having an atom of food in their crops or stomachs at this time.

The Indian proceeds to the Fort, and completes his winter supplies, which he obtains, whether he can pay for them or not. These consist of blankets, one for each member of the family, cloth for a new suit of clothes, capôt, flannel shirts, &c., axes, ice chisels, kettles, ammunition, twine for nets and for rabbit snaring, fish-hooks, the means of lighting fires, pipes and tobacco, possibly a small supply of tea and sugar, and a bottle of medicine. The family now proceed in their canoe or canoes—often there are two, one of which is small, in which the Indian goes a-head hunting—to their hunting-grounds, when they at first generally locate themselves on the shores of a lake well supplied with fish, if this position is at the same time consistent with a probable good stock of fur-bearing animals, or, what is perhaps still better, a plentiful supply of rabbits (*Lepus Americanus*).

Let me here say a word or two on the important place, as regards the Indians all over the country, which this little animal, the rabbit, occupies. Every nine or ten years the American hares or rabbits become very numerous, and are then attacked with a very fatal epidemic, of which they gradually die off in a few years. They are found sitting dead in their forms, usually under the spreading branches of young spruces and pines, which grow low down to the ground.* The disease spreads over many thousands of square miles of territory in the same season, although it can scarcely be communicated by contagion from one rabbit farm to another, as they are usually miles apart.

In the course of a few years, scarcely a rabbit is to be seen. They then gradually increase, and in the ninth or tenth year they are again at maximum. The effect is curious. When rabbits are numerous, the Indian pitches his tent near to or in the midst of one of their favourite resorts, cuts down a number of birch and other trees, the favourite food of these rodents, on which they fatten with great rapidity. The wife and children (if any) are meantime busy making small low hedges of pine in different directions across the runs of the hares, leaving a gap here and there for them to pass through. When the hares have got into good condition, a great number of snares are set in the gaps in the hedges, and in the morning 50 hares, or perhaps more, are found strangled. Whilst the rabbit snares are attended to by the squaw, the hunter has been building aseries of marten traps, at intervals of half or one-third of a mile apart, to the distance of twelve or fifteen miles on each side of his tent, in the direction most favourable for his object, of which he judges by the footprints in the snow of the animals he wishes to catch. The lynx, marten, fox, and fisher, all congregate to feed upon the rabbits, and finding tempting baits in the traps put their heads in and get caught.

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* The late distinguished naturalist, Sir J. Richardson, has been wrongly informed on this subject when he says that "no dead are found," and he assumes that the hares must migrate. This cannot be, as the epidemic attacks the whole range of country where the hares are to be found the same season.

It will thus be seen that the Indian is hunting under the most favourable circumstances, having food in the form of rabbits, and furs at his very door.

I may mention that rabbit skins, when properly joined together, make one of the warmest blankets possible, by being cut into strips, sewn together to form a long line, and then loosely netted. Although the fingers may be pushed with the greatest ease through any part of this blanket, a person may pass the coldest of nights wrapped in one without the slightest discomfort. An Indian child, dressed up in rabbit skins, like "Baby Bunting," is a funny looking, but very cozy little creature.

By the way, I seldom, if ever, heard an Indian child cry; certainly never heard one squall, as more civilised babies are in the habit of doing, nor ever saw one chastised. It would be thought very unnatural and cruel in a mother to flog or strike her child.

When the rabbits disappear, the Indian has either to fish, or to spend much time in hunting deer, or other large animals, for food; whilst the fur-bearing animals have also to scatter all over the country, with the same object, and are thus far more difficult to trap, the result being that the collection of furs becomes very much diminished, wholly caused by the dearth of rabbits. This, however, has one favourable effect—the martens, &c., while scattered over the country, have time and opportunity to increase in numbers, after being, perhaps, too much reduced by the previous facility of catching them during the rabbit season. As a rule, the Indian shows as much judgment in killing the beaver on his lands, as a farmer does in weeding out his stock. This he can do pretty easily, as usually the beaver is netted, and it can be seen without hurting it whether it is one the hunter would wish to kill; if not, it is let go again.*

Black and brown bears are sometimes shot, frequently snared in a peculiar manner, and often killed when in their winter dormitories, at which time they are easily knocked on the head. Not only the Crees, but all the Indians I know, treat with much ceremony and respect the body of the bear they have killed. He is placed in a sitting posture against a tree, and long speeches are made of apology and regret for having been under the disagreeable necessity of killing him. A somewhat similar ceremony is gone through by the natives of one of the northern islands of Japan (Yesso, I think), when a bear is killed, and a feast held. My authority for this is, to the best of my recollection, "Peoples of the World," edited by my friend, Dr. R. Brown.

As it is supposed by the Indian that even after he has been disembowelled the bear may come to life again, a piece of stick of the proper length, sharpened at both ends, is placed in his mouth, keeping it wide open, so that he cannot possibly close his jaws. For this additional indignity a profuse and humble apology is made to Bruin. I believe the supposed necessity for this precaution arose from the fact that a bear, thought to be dead, came to life again whilst being carried home, and took a mouthful out of one of the Indians carrying him.

Having alluded to a fishery as a means of obtaining food, I may mention that a good large lake, well-stocked with white fish *(Corigomes albus)*, is the most safe and sure source of food supply in America. Deer, buffalo, and rabbits, may fail, but a good fishery seldom or never does so. I have thus dwelt rather lengthily on rabbits and fish as an article of diet to the Crees, because it applies equally to all tribes of Indians, south of about latitude 60° north, and is, therefore, a question of great importance to them.

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* I read somewhere, the other day, that the beaver lies dormant during winter. This is a mistake, as he is wide awake, lively enough, and in fine condition. He would not think of laying up such a large supply of winter food if he was to be dormant.

The fur-bearing animals found on the lands of the Crees, are the black and brown bear, the white bear, near Churchill, the wolf, fox* (cross, red, and black), the lynx, fisher, marten, otter, musk, and musk-rat, and also the wolverine, which all trappers, whether Indian or white men, would wish to see exterminated. Unless the Indian runs short of something particularly requisite for use, he does not visit the trading fort during winter, but brings in all his furs in the spring, as already mentioned.

As may be inferred from what I have already said, the Crees are a fine docile race, with comparatively few faults, and these are injurious only to themselves. They are very fond of strong drinks, and have a very great dislike to agricultural labour on their own account, although they work very well for others when paid for it. They used, in old times, to have some rather unamiable weaknesses, which were put a stop to by the Hudson's Bay Company. One of these was, that when any of the tribe became old and unfit for work, his relatives, with, it is said, the sanction of the victim, had his life cut short by the use of the cord. The process was to take the aged hunter out of his tent, giving him a pipe of tobacco, and place him in a comfortable seat, whilst, close to his feet, a grave was dug. When this was ready, the affectionate relatives, with less ceremony than they used towards the bear, applied the cord, and as soon as death took place lifted the body into the grave, and covered it up. There was another practice, which was more easily stopped, but in a different way from that mentioned above. A band of "braves" used to assemble each spring, and being well armed with guns, proceeded to kill Eskimos at some fishing stations of these people on the East main coast; this was called the "Eskimo hunt." The plan adopted by the Company was to supply with guns the Eskimos, who formerly had only bows and arrows and spears; and nothing more was ever heard of the "Eskimo hunt."

In my time many Indians from inland districts came annually to Moose in the summer, as crews of the canoes that brought down the furs for shipment to England. These were of mixed tribes from Abitibbi and Temiscamingue, large powerful men generally, but not so good looking as the Crees. It was a very old custom to give to these voyagers about a pint of weak rum each, as a "regale" on arriving at the depot. If they did not get this, they would have felt themselves defrauded of their rights, just as a sailor in our navy might now do, if his grog were stopped without cause. In the earlier years, the Indians always took this allowance of rum, which led to a certain amount of intemperance,—but never to any quarrels or injury to anyone. Tea, sugar, or tobacco, to more than the value of the rum given, were invariably refused.* In a year or two the conduct of these Indians wholly changed for the better. They almost invariably accepted the substitute offered for the rum, and the one or two who did continue to take the "fire water" used it in small quantities at a time, so that it produced no bad effect. These Indians, during their stay at Moose, met every morning and evening in a large tent, where one of their number read or spoke the service they had been taught, in the most exemplary manner' and then all joined in singing a hymn in their native tongue. They were, at the time, hundreds of miles away from the priest who had worked this good work among them, so that they were in no way coerced by his personal control. The Catholic priest is of all others, the missionary who most rapidly and powerfully acts upon the mind favourably, and hence the life, of the Indian. His life of celibacy, the show and ceremony connected with the form of worship, his facility of adapting himself to the position in which he is placed, and, last of all, the common practice of the priest in learning the language of the tribe among whom he is to live, before ministering unto them, gives him a power and influence which few missionaries of other denominations possess. It was Father Mathew, many years ago, that converted the Iroquois, in the large village of Kauknawaga—one of the most drunken tribes in Canada—to temperance or total abstinence.

The Crees, when engaged in service, make faithful and obedient followers. I had two—Mistegan and Nibitabo—as hunters and boatmen, with me in the *Arctic*, and would never wish for better or more willing servants. Mistegan was one of the best boat and canoe men I ever saw in running a rapid, which requires much skill and practice; he was a good shot, an admirable snow-shoe walker and sledge hauler, and had great powers of enduring cold, as the following instance will show. He was with me one winter, in the barren lands north-east of Bear Lake, deer shooting, and one evening he did not return to camp*. I felt anxious about him as it was very cold, at least 50° below zero, or 82° of frost, and he had neither blanket nor axe to cut wood with him. The night passed, and a great part of the following day, when at last, late in the evening, our hunter came in with half a deer on his back. His story was that having wounded a deer he followed on its track a long way before being able to shoot it. He was both hungry and thirsty; the former he relieved by eating the marrow from the leg bones of the deer he had killed, the latter he quenched by roasting a piece of snow before a small fire, which he was enabled to make by breaking a few branches off a small pine tree, and catching the water as it trickled down in a piece of the deer's skin converted into a cup. The man was none the worse for his night's outing and his very long walk.

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* Strangely enough the red, cross, and black foxes, are all found in the same litter, the black variety being always the least numerous, but ten times more valuable than the red.

* I believe there is no rum now given, but even in former days, the total quantity supplied to an Indian in twelve months, did not equal that imbibed by what would be considered a temperate English or Scotchman during a week or ten days.

Many attempts have been made to induce the Crees to cultivate the soil, and raise grain and vegetables, as an addition to their animal food. That this should have proved a failure on or near the shore of Hudson's Bay is not surprising, for although the southern part of the bay is farther south than London, the climate is very much colder, chiefly because of the almost constant presence of ice all the summer, which acts as a kind of refrigerator. But even were the circumstances more favourable than they are, I, as an old sportsman who has roughed it occasionally, nearly as much as the Indians, can quite understand their preference for the more stirring, varied, and exciting life of the chase, although often accompanied by short commons and not a little suffering. The Crees have no chiefs, the fact being, that they now seldom or never band themselves together beyond a family or two.

Having occupied so much time with this one tribe, I must take a long leap to their first cousins, the prairie or plain Crees, passing by the Saulteaux of Lake Superior, and one or two other small bands of natives, of whom I personally know little. The manner of life of the prairie Crees differs in almost every respect from those frequenting the woods. Whilst the latter travel wholly on foot, or during the seasons of open water in canoe, their living consisting of a great variety of fish, flesh, and fowl, the prairie Crees perform almost all their locomotion on horse-back, except on particular occasions, when much caution is required, on the war-path, or on a horse-stealing raid. These horsemen, whilst resembling in some degree the wood Crees, are markedly different in appearance, being of slighter build, more wiry, and smaller limbed; their dress is almost wholly of leather, made from the skins of the buffalo, which, when numerous, supplied nearly all their wants, of bedding, clothing, moccasins, thread, &c. With the surplus meat and robes, combined with a few furs, usually of the coarser kinds, they purchase their kettles, axes, knives, tobacco, guns, and ammunition, although the latter two articles were not absolutely necessary, bows and arrows being very efficient weapons for buffalo shooting. To send an arrow right through a buffalo was not considered a very wonderful feat, but only done to show strength and dexterity, as it was preferred, for obvious reasons, to leave the arrow in the poor animal. As weapons of war in their fights with their enemies, the Blackfeet, guns were in demand. A Cree is seen to the greatest advantage when mounted on a spirited little horse, and in full dress (horse and man)—a fine subject for the artist! Yet, as horsemen, the Crees are often excelled by their half-breed brethren. This tribe are probably now some 3,000 strong, or less, and have always been on friendly terms with the Hudson's Bay Company's people, in whom they have great confidence—a fact recently recognised by the Canadian Government, who most gladly called in the aid of some of these officers (notably Messrs. William Christie and James Mackay), in making the treaties for the sale of the lands of this and other tribes.

A Mr. Rowand, many years in charge of the Great Prairie District, gained much influence over these Indians, and, among other hobbies, took great delight in vaccinating them by the hundred, when a large band visited Fort Edmonton. He used to make an oration to the chiefs, telling them that vaccination was a great medicine, and that it would save them from a terrible disease; so that they and their followers submitted readily to the operation. Some 45 years ago, when small-pox spread as a scourge over the prairies, Mr. Rowand's precautions saved this fine tribe. The disease was first communicated from people in a steamer to Indians of the Missouri in the United States. These sickened, and a great many died. Whilst suffering from the malady, a party of their next door neighbours, the Assiniboines, numbering thirty, took advantage of the opportunity to steal the horses of the sick and dying. They were successful in carried off a valuable booty, but they took with them the small-pox also; two-thirds of the robbers perished on their way back, and the survivors had to abandon their spoil, but carrying the disease with them to the camp, where it made great havoc. The young men of the Cree tribe could not resist the tempting opportunity of stealing some of the Assiniboines' horses, and did so without any fatal results, as the vaccination protected them. The plague was stayed, and did not proceed further north, although it spread along the American lines, throughout the plain tribes, to the west of the Rocky Mountains, down to the Pacific, and then north from Vancouver Island to the Russian settlements. Of the Mandans, so ably described and finely illustrated by Catlin, only twelve remained, and a party of Sioux went to extinguish this remnant of that once great tribe. I assume that since the death of Mr. Rowand, a good many years ago, vaccination has not been so closely attended to, for during an epidemic of small-pox that recently visited the prairie tribes, causing great mortality, the Crees suffered as much as any of the others.

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* Our camp was merely a piece of ground from which the snow was dug away, then some branches spread to form our bed, no tent, and only a scanty fire, as wood was not abundant.

In the probable rapid settlement of the great north-west prairie lands, the question of what is to be done with the various tribes, consisting of Blackfeet and Blood Indians, Crees, Assiniboines, and Sioux, numbering in the aggregate from 12,000 to 14,000, is a very serious and important one. It is very evident that when the larger game (buffalo especially) become all but extinct, and they are now very scarce, these Indians must have something to live upon, and the most ready resource (to them) will be the flocks and herds of the settlers, unless other means are provided. So far, the Canadian Government seem to have taken the very best possible means of meeting the difficulty. Reserves of land in favourable localities have been set aside for the Indians; farms have been established, with the special object of teaching them husbandry, the requisite agricultural tools have been supplied, so as to combine stock-raising with agriculture, the former pursuit being probably much the most suited to the tastes and habits of the Indian. At present the more turbulent of the natives are kept in order by a very efficient corps of mounted police, 300 or 400 strong, who have hitherto done their work remarkably well. A strong detachment of these are always in attendance at the annual payment of annuities to the Indians, and, whilst protecting the agents, at the same time prevent disreputable traders from bringing spirits to sell. If any such are discovered, the whisky cask is smashed, and all the owner's property confiscated.*

The Assiniboines, or one band of them, calling themselves the "young dogs," a mongrel lot indeed, are the most disreputable Indians on the prairies, and gave a hunting party which I accompanied, about 20 years ago, much trouble by their persistent efforts to steal the horses (some of them valuable animals), in which, they on one occasion, very nearly succeeded. Our guide, to whom the horses belonged, was extremely annoyed, not only from the fear of losing his property, but also from the Indians constantly hovering near us, scaring the game away. At last the guide (McKay). adopted a plan which proved eminently successful. Among other peculiarities of the Indians, there is one which men of my profession should consider extremely praiseworthy. They have a great respect and regard for a medicine man, especially a white one, not unmixed with a wholesome fear, and it was this last feeling which McKay, without my knowledge, brought into action. On these Indians first coming to see us, they were suffering much from ophthalmia, and I gave them some eye-wash. On coming to our camp some days afterwards, while I was absent shooting, they told our guide (who spoke their language fluently) that their eyes were very much better, but that they wanted some more medicine. McKay told them the Doctor (meaning me) was very clever, and kind, and good, and that he could cure their eyes, but that he was very angry with them for following us, and preventing us from hunting, and that if they continued to do so, he might perhaps get more angry, and make his medicine destroy their sight altogether. I came into camp before these Indians went away; they were a powerful, but extremely repulsive looking lot, and I could not account for the timid and alarmed manner in which they looked at me, in strong contrast to their former somewhat insolent demeanour to all of us. When shaking hands they actually trembled. On speaking to McKay on the subject, he laughingly told me the whole story, at which I was much displeased, although the ruse was most effectual, for we saw no more of our troublesome visitors. During much intercourse with Indians and Eskimos, I have always avoided making any statement to them that in any way deviated from fact.

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* This is a very different state of things from what is *now*, or *was*, some years ago common on the south side of the boundary line, where, on similar occasions, the Indians were often drunk for days.

The assumption of, or having ascribed to one, powers one does not possess, is not only wrong in itself, but leads to unpleasant consequences. A distinguished naval officer, when on Arctic service, made the Eskimos believe that he possessed supernatural powers; that the great guns when fired (this was done for some experiments on sound) gave information of the stealers of certain things from the ship, &c. One of the officers, on going one morning to the snow-huts of the natives, to obtain a guide, was surprised by all the men rushing out of their igloos, furiously brandishing their spears and lances. The lives of this officer and his companion would probably have been sacrificed in a moment, but for the courage and address of one of the women, who ran fearlessly up to the officer, and explained the cause of the excitement. That morning, a stone, carelessly placed, had fallen on the head of a child, and killed it; and this the Eskimos attributed to the supposed supernatural powers of the Kabloonans. The officer knew enough of the language to give an explanation, and peace was at last restored.

A somewhat similar case, which terminated more fatally, occurred in British Columbia, in 1864. A party of men were road-making, for a Mr. Waddington, and when winter began, they deposited a quantity of provisions in their log hut, fastening the door. When they returned, in the spring, all, or part of the provisions had been stolen; and the white men accused a party of Indians whom they knew well, and were on friendly terms with, of the theft, and demanded payment from them. The Indians stoutly denied the accusation, on which one of the road-makers said, "If you do not pay us, we will bring that disease among you," at the same time pointing to one of his comrades that was deeply marked with small-pox. The Indians went away, held council, and came to a decision that as this terrible disease would destroy themselves, their wives and children, they would be beforehand with those who threatened them. The very next night, at a given signal, the tents of the whites were simultaneously thrown down, and every man, with one exception, stabbed whilst helplessly lying underneath. The man who escaped happened to sleep that night not in his own tent, a circumstance not known to the Indians, and when the tent fell upon him, suspecting danger, he kept perfectly quiet, and remained so until he supposed, from the silence, that the Indians had gone away. He then crawled cautiously from the tent, and made a rush for a river near, but the Indians were at his heels, and as he was dropping himself from a branch into the water, a blow with a knife or an axe was struck at his hand, which disabled it, yet he managed to swim across and get away. I saw these Indians at Fort Alexander when brought in as prisoners. They all protested that they did not steal the provisions, and they had now given themselves up to save their wives and children from starvation.

I have now to describe briefly an Indian tribe, differing much in various ways from those already spoken of—the Dog-ribs or slaves, numbering perhaps about 1,000. This tribe frequents the lands on the borders of Great Bear Lake, to the south and east, and also the neighbourhood of the McKenzie River and its tributaries. During two winters passed at Fort Confidence, on the east shore of Bear Lake, I saw much of the Dog-ribs, or "slaves" as they are called by the Copper Indians, who hunted for Franklin's overland party in 1819-21, and who used to tyrannise in the most cruel manner over the Dog-Ribs, carrying off the finest of their young women, and robbing them of their property whenever they had a chance. At last, after much suffering, the slaves combined, and formed a plot with much secresy, for the destruction of their oppressors. This plan was so effectually carried out, that the greater part of the Copper Indians were killed, with but slight loss to their enemies, who were thus relieved from constant dread and trouble, for the remnant that escaped have never recovered their former ascendancy.

The Dog-ribs, both men and women, have bright and sparkling eyes, are pleasant, cheerful, and lively, but are much addicted to falsehood and exaggeration, given to panics on the shortest notice, and for the slightest cause; some unpleasant dream, or the marks of a strangely shaped snowshoe in the snow, will drive them from their hunting-grounds to the Fort, in great alarm, with rumours and stories of the most wonderful kind, and it is impossible to convince them that there is no danger, and nothing but stopping their rations will make them proceed to their hunting-grounds again. They have some good qualities, however, being cheerful and pleasant companions, ready to go with the white man anywhere. They are kind and indulgent husbands, the wife having, in most cases, much influence, possibly because it is not unusual to decide the right to a wife by a wrestling match, the lady sitting by, an apparently careless and indifferent spectator of the struggle for possession. There is, I am told, no other ceremony than that the victor, whether her former husband or not, claims his wife.

All the superstitions of these poor people are most injurious to themselves—for instance, they will never tame a deer, as they think the doing so would bring death or misfortune; otherwise they might domesticate the reindeer, as the Lapps do, and have the means of a constant supply of food; for the barren lands of Arctic America are quite as good feeding-grounds as the shores of Lapland and Siberia.

They have another most unfortunate practice, which it has been impossible to break them of. On the death of a near relative they destroy every article of property of value they possess, retaining perhaps an old deer-skin robe and a few other articles. I had a curious example of this absurd practice. On our way through Bear Lake, in 1848, to Fort Confidence, Mr. Bell met on the shores of the lake, a fine old Indian perfectly destitute, except a dirty, worn-out robe, a wretched canoe, and a few fathoms of net. He was considered a well-to-do Indian, but having lost his wife, all his property was consumed. Being well known to the guide as an excellent fisherman, he was taken to the Fort, and installed in that office, in which he did his work admirably, catching more fish than the regularly-engaged fishermen, probably because he knew the lake better. He was a great favourite, and when we left the place, in 1849, he was furnished with a good supply of everything he required, besides being fairly well paid for the fish he had caught.

It happened that I had to return to Bear Lake in 1850, and in going along shore, we again found our fisherman as poor and destitute as he had been in 1848. He had lost a daughter by death, and showed his grief in the usual wasteful manner. He was again engaged for his old duties, which he performed satisfactorily, and he was again placed in comfortable circumstances in 1851, but if another death occurred, there would be another destruction of property. These two examples will illustrate the difficulty that the Hudson's Bay people have in dealing with these Northern Indians. Supposing that this old fisherman had been an active and good fur-hunter, the property destroyed, to the value, perhaps, of £10 or £20, would not have been the Indian's but the Company's, for which they would have been paid in the spring, by the furs killed. But as the Indian who loses a relation does not hunt during the season that the loss occurs, he comes back to the Fort destitute, and must have a fresh stock of goods on credit, for the winter, and may have to be fed gratuitously for some time in addition, for it is the universal custom, that if starving Indians come to a trading post, they are fed without payment, until able to return to their hunting grounds, or if not able to come to the Fort, food is immediately sent to them.

The tariff of the Hudson's Bay Company is very peculiar, and is often the cause of misrepresentation, intentional or accidental. The payments made to the Indian for furs are far higher, in proportion of value, for the inferior skins, than for the finer kinds, such as the marten, silver fox, otter, &c., whilst for the musk rat, which at some posts forms about half the bulk of the furs, there is little or no profit. The cause for this peculiarity is, that if the Indian were to receive for a marten the same proportionate value that he does for a skin of perhaps only a tenth its price in England, he would follow up to extermination all these dearer and finer furs, as takes place when a fur country becomes occupied by settlers, as is the case in Canada.

The fair way to examine into the Indian tariff of the Hudson Bay, is to compare it with that of their neighbours, the Americans and Russians. I have known Indians come a long distance from the American side to purchase guns, blankets, &c., from the company, because they were better and cheaper than they could be obtained from their own traders. When in the McKenzie River district, I found that the Russians charged nearly double, and in some cases more than double what was charged by the Hudson's Bay Company. Nay, more, some of our naval officers on active service, one or two of whom, in their ignorance, have not been sparing in their remarks upon the company, actually gave less in payment for venison to the natives near Behring Strait, and for fish elsewhere, than the ordinary price paid by the company. For instance, the carcases of 12 deer were brought to the ship by a Kutchin, for which a musket was given in payment. The same payment would have been given for seven or eight deer in McKenzie River, and it would have been hauled home by the people of the Fort, sometimes from three or four days' journey distant, probably more than a quarter of the venison being necessarily consumed as provisions on the way.

I have not yet mentioned that with nearly all Indians, there is a certain favourite piece of deer or bird tabooed to the women, which they dare not taste under a severe penalty. The Chippewyans taboo the moose nose, the wood Crees taboo some part of the wild goose, and the Dog-ribs taboo the reindeer head. I learnt this latter fact accidentally. We were travelling through the barren lands, and had killed some deer. We encamped beside some Indians who also had been successful, and in the evening, a great scene of feasting took place, much roasting and boiling going on. To the extreme left, at some distance, a large fire was burning (we had come to a clump of wood), and on approaching it, I discovered that there were no women or girls there, as at the others. On asking my interpreter what was the reason, he said that fire was for roasting deer's heads, and that the women were not only prevented from eating them, but dare not even approach the fire at which they are cooked. The process of cooking is very simple, the head is cut off, a piece of stick, hooked at the end, is fixed in the nose, and this is suspended from a pole with a string, close to the fire, and made to turn round. The hair is soon singed into a black mass, and, after the proper time has elapsed, the head is taken down, and all the black crust of burnt hair is removed, leaving the skin beautifully clean and white. On eating one of these, I found it the most agreeable food I had ever tasted, far too good, according to the Indian idea, to be wasted on a woman. I fear that little can be done for these Northern Indians, unless they could be reasoned out of their prejudices and superstitions, which, with their imprudence and wastefulness, are the causes of their being so poor.

In winter, 1850-51, much of the venison we had bought from the Indians in the early part of the season, was given back to them for nothing towards spring, to keep them from starving, not that deer were scarce, but owing to one of those scares or panics already mentioned, that drove the Indians from the hunting grounds, or made them too nervous to shoot straight. To show what confidence the Indian has in the white man in the interior of the territory, where other traders have not yet penetrated, if any one in this room were to be travelling there and in want of food, and were to meet an Indian who had some to sell, he would take in payment a scrap of paper or bit of bark with writing on it, which he did not understand, if told that he would receive so many skins on presenting it to the traders, as readily as any of us would take a sovereign.

The use of wine and spirits had been done away with long ago at these inland posts, and even the gentlemen in charge readily gave up their small annual allowance of wine and brandy, that the Indians might not have it to say that we took ourselves what we withheld from them. Although living on the most friendly terms, and taking a lively interest in their welfare, it is nevertheless necessary to guide and manage the Indian with a firm hand. A young man, on his first charge of a trading-post, has a very difficult part to play. He is placed at a great distance from any assistance, with perhaps four or five men, and there may be one or two hundred Indians coming in to the post, among whom there are most likely one or two young fellows, who are desirous to learn of what metal the new clerk is composed; and it will depend on the manner in which he passes through this ordeal whether his life among them is an easy or troublesome one. As a rule, it is thought that the officials of the Hudson's Bay Company have performed their duties to the Indians fairly well. The relations between them have almost invariably been of the most friendly character, and the usual term applied to us is that of "father," "brother," or "son," according to the respective ages of the individuals. In sickness or in health we endeavour to be their friends. Such was my experience of twenty years.

THE ESKIMOS.

Probably there are no people on the face of the earth, certainly not in British North America, about whom there is such a diversity of opinion, as there is with the Eskimos, or Innuit, as they call themselves. By the majority these are stigmatised as dirty, gluttonous, treacherous, untruthful, and dishonest; small, weak, and indolent; whilst a small minority find in them traits of character of the most exemplary kind, and good qualities possessed by few savages. Much of this difference of opinion arises from the season of the year in which the Eskimos are seen, and the locality where they live; for in a coast-line fully 5,000 miles, from Behring Straits to Labrador, and to Greenland, there is a diversity of the mode of life, and a variety of character, which can easily be accounted for by circumstances, although all are evidently from the same stock, if identity of language can be relied upon in arriving at such a conclusion. Eskimos from Labrador and East Main are found to be able to communicate freely with those at the mouth of the McKenzie River, 3,000 or 4,000 miles away.

During the short summer of the Arctic regions, Eskimos are not seen to advantage, as they then wear their oldest and worst clothing; those of Greenland and the west shore of Davis Strait, and Baffin's Bay, cannot look particularly clean at any season of the year, as their hot, half-underground winter dwellings are filled with smoke and smuts from their fire lamps. For this statement my authority is Kane, Hayes, and some whaling captains. The Eskimos of the McKenzie River, have, indeed, always shown hostility to whites, and a wild-looking, powerful set they are; no one of my crew, consisting of fairly strong sappers and miners, and sailors, could detach the hold of these fellows from the gunwale of the boat; to do this, Sir John Richardson in his boat rapped their knuckles with a stick. The reason of this hostility is easily accounted for; they are at constant enmity with their next neighbours, the Loucheux, with whom they have blood feuds. These Indians, in the course of barter with the white traders, obtain guns, which they use in their fights with the Innuit; hence, these last think us hostile to them, or at least friends of their enemies. On all the coast east of the McKenzie, the white man has been received and treated as a friend.

Three visits to the Coppermine River, and two winters among the Eskimos of Repulse Bay, gave me a most favourable impression of the natives of these places. At the former place, some of these men were tall (5 ft. 10 in. or 5 ft. 11 in.), well and cleanly clothed either in deer or sealskin dresses, at once friendly but unobtrusive, hospitable, and obliging; they readily helped us in crossing some streams, and without apparently expecting any remuneration. When presents were made them, they invariably offered something in return. As Simpson did some 12 years before, I ordered a pair of waterproof boots for my journey across land in the autumn, and, I believe, from the very same Eskimo, who there and then took the measure of my foot. They had left the Bloody Fall (a famous fishing station on the Coppermine) before our return, but there was a very fine pair of boots dangling from a pole; so the Eskimo had kept his promise. The boots were removed, and very liberal payment in the form of knives, files, needles, &c., carefully wrapped up, and put in their place.

Some writers have said that the Eskimo is inferior in strength to the white man, but this I am inclined to doubt. When travelling from the Arctic coast to Bear Lake, in 1848, a journey of twelve days duration, over a rough country, Albert, rather a small-sized Eskimo, carried with the greatest ease a heavier load than the sappers and miners did, the latter being usually very tired at the end of the day's march, while Albert was quite fresh, and able to walk miles afterwards in pursuit of deer and other game. Onligbuck (*père*) who had been interpreter in several Arctic Expeditions, beginning with Franklin in 1825, was, although slow, a very powerful man, and his son, when with me in 1853-4, hauled a heavy sledge as well as my best sledge haulers, and only broke down one day, when he had taken a great feed of cooked seal's flesh at the snow-hut of a countryman, and we had immediately afterwards a somewhat steep hill to ascend through soft snow, which tried us all a good deal. Onligbuck was on this occasion our snow-hut builder, which gave him about an hour's extra work when we encamped. In 1847, I took with me an Eskimo, named Ivichuk, on a journey of over 500 miles. He had the same daily rations as myself and the others, not too abundant; and although he had the additional labour of building our snow-hut every day, he stood the work very well indeed, although he did not like the pemmican, as food, to which he was unaccustomed. All the Hudson's Bay Company's officials who have had dealings with the Eskimos, either at Ungava, Churchill, or East Main, prefer them to any of the Indians of the territory, and the same is the case with the missionaries at Labrador. As to the truthfulness and good memory of the Repulse Bay Eskimo, I had an excellent opportunity of testing these, because some of them, when young, had been on board Parry's ships in 1823, that is, 24 years before, and they mentioned circumstances that took place then as nearly as could be as they were told in Parry's or Captain Lyon's journal, It was the same with regard to Sir John Ross at Boothia, in 1829-32; none whom I saw, it is true, had been on board his ship the *Victory*, they, however, told me, with correctness, much that had occurred. They have not the gift of figures, and cannot remember dates. All important particulars regarding the fate of Sir J. Franklin's party communicated to me through my interpreter, turned out to be correct, even to the fact that all the books and journals had been destroyed; close search has since been made, and none have been found. A story has been told, coming from some whalers, who visited Pond's Bay near 600 miles north-east of the scene of the sad disaster, that Franklin's people had been murdered by the Eskimos. I do not believe this, and will tell you the reason why.

1st. Men go the north with hobbies, or preconceived ideas, and are naturally desirous that these ideas should turn out true; they put leading questions, and often thus make out a case that has no foundation in fact. There are a good many instances of this. Kane went up Smith Sound determined to find an open Polar sea. His servant, Morton, found one for him, which turned out afterwards to be only an open pool, such as is seen at many places in the spring.

Chief Justice Daly, President of the American Geographical Society, expressed an opinion that "Franklin had been murdered by the Indians, who had already imbrued their hands in the blood of white travellers." We know that Franklin died in 1847, and could not be alive with his party in 1848. We know also, that the only Indians that the unfortunate men could have met, were those that not only had never killed a white man, but were of the tribe who had nursed Sir J. Franklin and his people on a former Arctic expedition, when at the point of death from starvation, with a tenderness and care worthy of all praise. Such is the way in which falsehoods spread.

2nd. Although I specially asked the Eskimos from whom I received the information, and who were not on friendly terms with those who saw the starving white men, whether there had been any of them killed, the answer was invariably no, and the same has been the case ever since, although the natives have, since my time, been taught to drink grog by our American cousins, and would be apt to let out the secret in their cups, if there was one.

When I returned from a long journey in 1854, I found nine or ten strong natives living near my three men, at winter quarters, on the most friendly terms, although, had they wished, they might have murdered them easily,* there being an immense temptation to do so, in the boxes full of knives, saws, files, &c., which were lying on the rocks, with no other protection than an oil-cloth. The clothes of both sexes are neat, tidy, and clean, so much so, that even after being worn for the winter, they can be used by the white man without any discomfort, a marked contrast to the filthy sheep-skins which form the clothing of many easterns, abounding with swarms of active and hungry entomological specimens, by no means conducive to rest or comfort. Both Simpson and myself (after an interval of 12 years) saw on the coast, east of the Coppermine River, large bales placed on high rocks, inaccessible to animals. These, on examination, were found chiefly to contain winter clothing, which was as carefully packed away as dresses in a ladies' trunk, and perfectly free from smell or impurity. Of course we repacked the bale (which was covered with some large musk-ox skins) without removing anything, but placing inside a very handsome present of ironwork.

The Eskimos are said to be a diminutive race, but I have studied the true Londoner, and, without actual measurement of either, I am inclined to think that the Eskimos are as tall as the natives of our great city, and much heavier. When sitting, an Eskimo does not look short; the defect of stature is probably due to the shortness of the lower limbs. On mentioning this to Professor W. H. Flower, of the Royal College of Surgeons' Museum, the very highest authority on such subjects, he mentioned to me a very curious fact, namely, that of three Eskimo skeletons he had examined, two of them had each an additional bone in the vertebral column, that is, twenty-five instead of twenty-four. The women, when young, are pleasant looking, almost pretty little creatures, extremely solid and compact, with small feet and hands, and well formed limbs, On one occasion my own man, a powerful fellow, accustomed to carry heavy weights, having to lift some of these young women out of a boat, they not wishing to wet their feet, told me afterwards that they were the heaviest things he ever carried, and but for very shame would have dropped them. He took them up in his arms as he would a child, and hence his mistake. I have already spoken of the activity and powers of endurance of certain Eskimos in comparison with whites; I also tested their strength in lifting weights; some of my fellows I knew could lift 400 or 500 lbs. I found that the difference of strength between the two races was very slight, and in some cases so close that, fearing that some one might come who would excel my men or myself, I closed the competition.

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* This was only a few years after the sad fate of Franklin's party. If murder had been committed then, would it not probably have been repeated on my three men.

I may be laughed at for saying that the Eskimos are scientific, but I think I can prove the fact. The goggles which they have invented to protect their eyes from the glare of the snow, with its narrow slit, to admit only a small amount of light, the blackened inner surface, and the peak (like that of a cap) to keep the sun off, are all perfect. The Eskimo's mode of building his snow-hut—only about six inches thick in the wall—would puzzle an architect or an engineer, until he saw how it was done. The bed-place in his snow-hut is raised above the level of the top of the low door, so that those sitting or lying upon it are out of the draught, and in the upper or warmer air of the interior. On one occasion, the drifting snow, during a gale, was cutting away the weather side of my hut. I told my men to pour some water on the snow, to harden it. The Eskimos present remarked, "It was not good to do that, as it made the house cold." Once, I found a man, when about to build his snow-hut, digging several feet down into a drift-bank for building material, although the surface snow looked in excellent condition for the purpose. On asking the reason, he said he wished to get the warm snow. This warm snow I found to be formed of much larger crystals than that on the surface. Probably, experience had taught him that it was a better non-conductor. The man strips to the waist, as if preparing for a pugilistic encounter, when going to bed during winter, and the child is carried, perfectly naked, in the hood of the mother, the object of both being the conservation of caloric. Ask ten people in England, how would they heal frost-bite? Probably, eight of the ten would say, "Rub with snow." The answer would be right if the frozen person were taken into a warm house, but wrong if he was at the time exposed to the low temperature that was freezing him. This lesson was taught me by a little Eskimo woman one very cold day; she saw my cheek white, and immediately applied her warm hand to the part, pressed it gently, and moved the skin and flesh over the bone underneath; the circulation was immediately restored, without either wetting or cooling the hand, or abrading the hard and frozen skin by snow friction. This was science and common sense. Their iced sledge runners enable them to haul a double load. The Eskimo kayak is as perfect a model for speed as the most perfect racing boat, compatible with sufficient breadth to carry a seal on deck if required. The Eskimo is the only canoeman known who can capsize his canoe, and, without leaving his place, right her again. His salmon spear is the most perfect I have ever seen; and his harpoon is so formed that it cannot possibly "draw," as the whalers say; the line may break, but the harpoon head is a fixture.

The Eskimos have a tradition that they came from the setting sun, and that they crossed water, probably Behring Straits. They certainly, to my mind, give the idea of a former more civilised condition. They treat their wives kindly, are grateful for kindness, which they showed in a very delicate and pleasing manner, by bringing us seal's fat when we required it, and taking no pay, because, as they said, we had been kind to some of their old people who encamped near us, and were under our care when the younger persons were away hunting. When sitting in the men's tent or my own, if they saw preparations for eating, they immediately got up to go away, but were, of course, asked to remain and share our food, if our larder was well stocked. The old folks left in our care never begged; and it was only by sending my servant to their tents that I found they were out of food. During the two seasons, the value of a sixpence was never stolen from us; on the contrary, we could with safety leave our tents in charge of some of the older people. I saw no instances of the huge feeding so often attributed to them. We are apt to forget, or many people do not know, that a mixed diet of bread and meat will be quite as satisfying as twice the weight of meat alone. Sir John Richardson was surprised to find that his sappers and miners, when at Bear Lake, consumed about 7½ lbs., the full ration being 8 lbs. venison per day.

I have said much, and, if space would admit, could say a good deal more, about my friends the Eskimos, but I hope I have already given evidence enough, not only from my own experience, but from that of others, that I have had cause to form a high opinion of them. All Eskimo interpreters, from Augustus and Ouligbuck with Franklin, in 1826, to the present day, have proved faithful and true, sometimes under severe trial.

DISCUSSION.

Mr. Stavely Hill, Q.C., M.P., said he almost felt that to attempt to make any remarks on a paper read by Dr. Rae, the person probably most competent to speak on the subject of any man in England, was to take too much on himself, and it was only because he felt he could supply a little more recent information as to the people who had been described, that he ventured to rise. He had had the pleasure of spending last autumn, and hoped to spend the next, on the prairies, and he had the greatest pleasure in speaking of the conduct which had been observed by the Hudson's Bay people towards the Indians, and also as to the feeling which that excellent conduct had generated in the Indians themselves. One did not like to make comparisons, but he could not help noticing the difference in the feeling amongst the Indians towards the English whom they recognised as intimately connected with the Hudson's Bay Company, and that which they entertained towards those on the other side of the boundary line. This had only been brought about by the fact that, as one heard on all hands, they had always been treated by the Hudson's Bay people with the most perfect honour and good faith; and this had led to a similar feeling on the part of the Indians. One day last October he had the pleasure of seeing two Crees come galloping down on their shaggy ponies; and they certainly answered the description which had been given of them, as about the most picturesque fellows you can imagine. When he gave them some tobacco, one of them put his hand behind his saddle to unfasten two ducks which he wished to offer in return. The only thing which at all detracted from the pleasure of meeting them was their habit of dressing their hair with skunk oil, which made it advisable always to keep to windward of them. The prairie life was certainly most delightful; to lie awake at night, hearing nothing but the little prairie dogs, and the great wild goose flying overhead, was the most enjoyable thing possible, and he hoped to experience it again next autumn. It was most interesting, also, to go into one of the Hudson's Bay stores when the Indians were coming in to purchase their outfit. The man knew he was acting honestly and honourably, and he did not like to be watched. He walked into the shop, and made a little *cachet* for himself in one corner; then he walked about, picking out a few needles here, a knife there, and a blanket or two somewhere else, and would perhaps take a couple of days in getting the whole of his outfit together. During the whole time, he was most punctilious in not touching anything he did not mean to take; he would look all round it until he was satisfied, and at last, when he had his little pile complete, he would get one of the gentlemen in the store to go through it with him, and tell him what it was. He knew he was to be trusted himself, and he would not submit to anything which at all derogated from that feeling. He certainly hoped that feeling would still continue now that we had come into the place of the Hudson's Bay Company, and should be very sorry to see any such feelings spring up as were found on the other side of the boundary line. He feared he had heard lately that there was not quite the same good faith altogether in these farming transactions as in the old days; but he hoped there would be no attempts made to take advantage of them, giving them old cows when they wanted heifers, or bad faith shown towards them in any way. They had been accustomed to expect from the Hudson's Bay stores the very best things it was possible to get—so good, indeed, that he had brought the remnants of his tea home to England for his own use. That company had been the most excellent pioneers and civilisers in that country, and he hoped in all our dealings with the Indians we should prove worthy successors to that great company of which Dr. Rae had been one of the greatest ornaments.

Mr. E. HEPPLE HALL said he came that evening expecting a great treat, and he believed all present would agree with him that they had had one. He looked on Dr. Rae as the greatest living authority on the subject he had spoken of; but as President Lincoln used to say, when he saw a fence rail down he liked to pick it up, and he was sure Dr. Rae would thank him for pointing out any omission. Now, with regard to the Eskimos, who had been spoken of very favourably, and he believed quite justly so, he had been always very anxious to find out where the Eskimos proper came from, and looking at this paper as one of the most valuable contributions to a knowledge of that interesting people, he should have been very glad if Dr. Rae had given them some ethnological information with regard to them; he should like to know very much where they came from, whether they were originally Asiatic, and had come across Behring Straits by those submarine formations which existed at a higher level in days gone by. He believed that was the scientific theory, and he should like to have Dr. Rae's. The Wood Crees and the Prairie Crees had been spoken of, and he had some knowledge of both, for it was his good or bad misfortune, when a boy, to spend 15 months amongst them without seeing a white face. His knowledge of the Crees, though not so extensive as Dr. Rae's, led him to think that something might yet be done with them. A great effort was being made in their behalf, and it was most gratifying to any Englishman—to any Christian, in fact—to find the Crees, who, many of them, were little better than the Digger Indians of California, showing themselves capable of being christianised, but of more than that, of being able to work and sustain themselves. Last year it was his pleasure to take out a few young men, who were anxious to possess farms of their own in the North-West, and he went out to the Great Dacotah Reserve, where he found many Sioux Indians at work on the Assiniboine River. It was a most gratifying feature to find that in consequence of the grand education which the Hudson's Bay Company had given to the Indians in the North-West, they had become self-supporting. This fact was touched upon by Mr. Pope, the Minister of Agriculture at Ottawa, in his last report, and also by the Indian Special

Committee in Canada. In conclusion, he should like to have Dr. Rae's opinion as to the practicability of establishing a route for steamers to the North-West, just as New York, Boston, and other parts were routes to other inland portions of the continent.

The CHAIRMAN said he had no doubt many present would have liked to hear Dr. Rae's views on the ethnology of the Eskimo; but he feared that, if he had gone into that subject, they would have been kept there all night.

Dr. MANN said the paper was full of most interesting information, and more than that, experience, which was of the greatest value. He would like, in connection with the topic last mentioned, to draw attention to the admirable account of a very analogous people, the Chukches, contained in Professor Nordenskjold's narrative of the voyage of the *Vega* round Europe and Asia. A long chapter in the second volume was filled with an account of those interesting people, who were, no doubt, the representatives of the Eskimos in that part. Professor Nordenskjold was extremely anxious to find whence these people came, but it would be seen there how very difficult these ethnological questions really were. He came to the conclusion at last that in these people he could trace American Indian blood, indicated in recurrence to original type when they were favourably circumstanced. In others, he found a clear development of the Asiatic or Kalmuk type, and in others, again, traces of Russian blood. His observations, therefore, led one to think that there was more mixture in these races than would at first sight appear probable. One thing regarding these Chukches interested him very much, and that was the large use they made of vegetable food. Nordenskjold found that it was their habit during the short summer, to cut young shoots of shrubs, particularly of a small kind of willow, and a rhodiola, when they were succulent, and to bind them in bundles, enveloped in skins, leaving them to freeze in the autumn for future use. The whole race did not number more than 2,000, so that a very large supply was not required, and when required they were sliced and eaten in the frozen state. Another interesting point was as to the use of ardent spirits, which had also found its way amongst them. There was no doubt that they were given to intoxication, when they could get hold of what they called *ram*, and they indulged in it for the pure love of intoxication. They did not care for the taste of the spirit, but thoroughly luxuriated in the effect of intoxication, and seemed to think it a great thing to get intoxicated occasionally. They were an ingenious race in many ways, and he noticed this particularly in the way in which they killed small birds. They shot them with blunt arrows, but not being particularly skilful in this, they had another plan of killing them by means of slings. A large number of small fragments of bone were tied together by long strings from a central knot, and when they were slung, of course they spread out, and the chances of the bird's escape were much diminished in consequence of the number of bones which were flung around them.

DR. RAE, in reply, said he had not gone into the ethnological question, not only for want of time, but also because he should only have been repeating what he had said in a long paper read before the ethnological Society some years ago. He believed the Eskimos came from the west, but the curious thing was, that while those at Behring Straits had large boats, when you came to the centre of the American coast they had not, and their houses and manner of life were different. Again, when you got to Greenland, where they were amongst the whales, walruses, and seals, they had the same habits as at Behring Straits—lived in underground houses, and had fire lamps simply because they were again amongst the same conditions. Where they lived in snow houses, and on musk cattle and deer, they were of course cleaner and nicer looking. Dr. Mann was quite right as to the mixture of blood; in fact, that was the only way in which the different shaped heads could be accounted for. The Eastern Eskimo were long-headed, while those near Behring Straits were brachycephalic; the eyes were much the same in all, inclining at an angle downwards. With regard to the Crees, he had the highest respect for them, and hoped something would be done for them. The Plain Crees might be trained to do something, but with the Hudson's Bay Crees there would be great difficulties to meet. Where they could grow Indian corn, they might come to something, and when he spoke of their being hardly fitted for agriculture, it was merely with regret. He had not much faith in the Hudson's Bay as a route for vessels; the bay itself was all right, and vessels might go their four or five months in the year; it was the straits which were so uncertain. He did not say ships could not go there, but they would require to be peculiarly built, of wood; the insurance would be high, and each voyage there and back they might be detained for many days. A steamer would run the extra distance through the lakes and round by the more southern route more safely, and there would be a month or two more navigation through Lake Superior. That was his feeling, having been through the straits three times: once they were nearly blocked; once they got through with difficulty, and once quite easily. The straits got blocked with the ice drifting down from the north. He should be delighted to see any route opened which would compete with the Pacific Railway, because it would be a good thing for the North-West. The only way to try it, would be to send a vessel to cruise through the straits all the summer.

The CHAIRMAN said he could confirm what Dr. Rae had said. The best authorities considered that steamers could not pass those straits. Steamers must be either iron or steel, and it was a question whether either of those would stand the intense cold and collision with ice without cracking up like glass. As the hour was now late, he would not detain the meeting longer than to propose a very cordial vote of thanks to Dr. Rae for his valuable and interesting paper.

The vote of thanks was carried unanimously, and the meeting adjourned.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 22nd, 1882; H. TRUEMAN WOOD, B.A., Secretary of the Society, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Brooks, J., Holmefield, Barr-hill, Pendleton, Manchester.
Evans, John, The Green, Stratford, E., and 134, Fenchurch-street, E.C.
Ferguson, Alexander, 38, Rockmount-road, Upper Norwood, S.E.
Mather, John, M.I.M.E., London and South-Western Railway, Locomotive Department, Nine-elms, S.W.
Mather, William, Salford Iron Works, Manchester.
Marten, Edward Bindon, Stourbridge.
Napier, James Murdoch, 68, York-street, Lambeth, S.E.
North, Frederick William, Rowley-hall, Dudley, and 34, Clement's-lane, E.C.
Richards, Josiah, Pontypool Iron and Tinplate Works, Pontypool.
West, Nicholas James, C.E., Foundry-house, Hayle, Cornwall.
Williams, Peter, 5, Bank-buildings, E.C.
Wilson, Wesley Williams, M.I.M.E., St. James's-gate, Dublin.
Wood, Edward Malcolm, 2, Westminster-chambers, S.W.
Wood, Lindsay, M.I.C.E., Southill, Chester-le-Street.

The following Candidates were balloted for and duly elected Members of the Society:—

Beetham, Arthur, 1, South-square, Gray's-inn, W.C., and 4, Leigh-road, Highbury, N.
Harben, Alfred, 3, Melita-villas, Victoria-road, Charlton, S.E.
Jowitt, Albert, Hawthorne-lodge, Clarkehouse-road, Sheffield.
Lever, Ellis, Bowden, Cheshire.
Young, Lieut.-Colonel John Richard, 20, Windsor-terrace, Newcastle-on-Tyne.

The paper read was—

THE TONIC SOL-FA SYSTEM.

BY J. SPENCER CURWEN.

President of the Tonic Sol-fa College.

I have undertaken to explain to you the Tonic Sol-fa system of musical instruction. Many of you have no doubt heard of this system, and your eyes have perhaps caught its notation, which has appeared to you a sort of musical Chinese. Doubtless your conservatism has been stirred as you have looked at what are to you unsuggestive and meaningless dashes, letters, and punctuation marks. You have asked yourselves whether the notation which was good enough for Beethoven is not good enough for everyone else, and you have given this intruder, this new-fangled craze, a mental kick, and consigned it to the lower regions of art.

English people do not like new things, and Shakespeare, when he says "old customs please me best," strikes a truly English note. At least we require that the necessity of an innovation shall be clearly shown before we give it our consent. It will be my task, therefore, to prove to you that this Tonic Sol-fa system, and the musical notation that is inseparable from it, are justified by public needs.

I start with the proposition that the main problem of musical instruction is to teach people to read music as they read a newspaper. There can, of course, be very good and tasteful singing, and even playing, which is wholly by ear. The French Orpheonists, several hundreds of whom came to sing at Brighton last September, are generally unable to read music, yet their intonation is remarkably good; they sing in better tune than our own choirs, they perform unaccompanied pieces of music which last a quarter of an hour without flattening, and they sing with delicacy and point.

But think for a moment of the position these Orpheonists are in. The pieces they sing are learnt by heart, by a wearisome process of iteration. They are taught like parrots. When a piece is learnt, they are no nearer learning a second piece than they were before they began the first. This process requires so much patience on the part of the teacher and taught, that few will submit to it. If music is to become common, we must teach people to read it; we must make musical performance easy of attainment.

How far are our amateur singers, and, for the matter of that, our players too, able to read at sight? Dr. Stainer says that you cannot walk round a drawing-room, without finding that the proportion is discreditably small. I was talking the other day to the leading teacher of singing in one of our chief cities, a gentleman to whom ladies of the best social position and the highest culture go—ladies upon whose musical education a large sum of money and of teaching power has been spent. In the course of conversation, he volunteered the remark:—"Not one in twenty of the ladies who come to me can read at sight." A similar testimony was borne, in my hearing the other day, by a member of a cathedral choir. He said that he had been present at many competitions to fill vacancies in cathedral choirs, and he could testify that where one candidate failed because of the quality of his voice, nineteen failed because they could not read at sight with sufficient certainty to pass the test. No doubt, the power of reading at sight is acquired, if time and practice enough are spent upon it, even without system. Sing week by week in a choir that gets through a quantity of new music, and your rule of thumb will gradually crystallise into science.

This, which I may call the "do it again method," is that by which most amateur singers stumble into a mediocre command of musical notation. They strike their notes by a series of lucky shots; it is in reality guess-work, guided by the instinct of ears accustomed to musical progressions. It is said of the ordinary notation of crotchets and quavers, that it tells you when you ought to go up, and when you ought to go down. This is, truly, about all it tells to a great many people.

Good instrumentalists have no difficulty in singing at sight. The keyboard has become interwoven with their mental habit, and to see a note is to feel what its exact sound should be. But these are the minority only.

What is the reason that sight-singing is so rare an accomplishment? Its decline is, perhaps, due, to some extent, to what is a great source of musical education in other ways—the popularisation of the pianoforte. The amateur singer, seated at the piano, picking out his or her notes of a song or a chorus part, is familiar to us all. This is the received way of learning a part in the nineteenth century. The pianoforte is employed as a musical "crib;" it saves so much trouble that everybody uses it. The habit is most unmusicianly.

There is, however, an explanation, if not an excuse, for the paucity of sight-readers, and for the habit of using the pianoforte as a "crib." The ordinary notation of the musical staff is very well, so far as it goes. It is a representation of the key-board of the pianoforte or organ, and fixes exactly the locality of each note in the scale of absolute pitch. But is this what the singer needs first to know? I will answer this question in the words of a distinguished instrumentalist, Dr. Stainer, the organist of St. Paul's Cathedral. He says:—

> "I believe that in ninety-nine cases out of every hundred the first impulse of a singer is, when a vocal part is placed before him, to consider the *relations* of the sounds to the key-scale, and to each other."

Now, the staff notation tells us nothing directly about the key-relationship of notes, and hence its weakness as an aid to the singer. To use the old logical terms, the staff notation denotes the pitch, and connotes the relationship of tones; while it would seem that an ideal vocal notation should denote their relationship and connote their pitch. The staff notation needs to be preceded by some introductory system which enforces key-relationship. This opinion is not individual; it has been held by various teachers, and on the chart before you, some of the contrivances having in view this end, the making the staff notation represent key-relationship more vividly, are shown. The plans are various. In one, the sol-fa initials are placed by the side of the notes of the staff; in another, they are placed within them; in a third, all music is written in key C, and the pitch at which it is to be sung is indicated at the beginning by the words "Pitch C," "Pitch B flat," &c.; in a fourth case the figures 1, 2, 3, &c., are used to indicate the notes of the key, being placed under the staff. All these plans point in one direction; they are confessions of the need felt by teachers at various times, and in various circumstances, of enforcing the attention of pupils to the key. To some extent they are valuable, but it is a question how far they really impart the power of commanding the voice by the eye from the staff at which we are aiming. The figures and letters upon the staff are like props, which, when taken away, are apt to cause the edifice to tumble down.

We do not use, in the Tonic Sol-fa system, any of these modifications of, or accretions upon the staff notation. We recognise the practical impossibility of altering or reforming the staff notation. It is the heritage of centuries, and is never likely to be changed even in a small degree. It is fixed by custom, and the enormous mass of printed music in it acts as a *vis inertiæ*, which repels all attempts at reform. We prefer to prepare our pupils for the difficulty of the staff notation by a separate and introductory notation. This period of apprenticeship served, the pupil is confronted with the staff notation pure and simple, and taught to read it without the help of any additional signs. He does so readily, because he is in possession of a key which enables him to unlock its perplexities.

There is another point about the staff notation which makes it defective for the purposes of singers. It treats C as the natural key, and all other keys as departures, more or less remote, from that. This is no doubt a fact of the keyboard, but it is not a fact for a singer. To him, one key is the same as another. Dr. Stainer puts this point very well as follows:—

> "Suppose I write a piece in the key of C, but on trial I think it not quite bright enough, and re-write it in C sharp. The singers have precisely the same parts to sing, they are only slightly altered in pitch—so slightly, that probably not one in a hundred notices it, yet, in the staff notation, I have taken them from the simplest known key into one which has seven sharps in the signature, involving double-sharps and all kinds of abtruse signs in modulating. What have the poor singers done that they should, because singing my work a mere trifle higher in pitch, be dragged from the pure sunlight of the key of C into the tangled mazes of seven-sharps-C and its related keys?"

But it is time that I explained to you the principles, and illustrated the processes of the Tonic Sol-fa notation and method. [Mr. Curwen here introduced a class of 30 boys, who were seated on the platform. He said they came from the Olga-street Board School, Bethnal-green, of which Mr. Park, the head master, and Mr. Bunting, the assistant master, were present. The boys received, like the rest of the school, two lessons in singing of 40 minutes each per week, and they were taught by the ordinary school staff, and not by a professional music teacher. His paper having been fixed at a week's notice, the boys had received no special preparation. They had no idea until last Wednesday morning that they would be there. Mr. Curwen was not sorry for this, as it afforded proof that the results produced were those of ordinary school work. The boys were put through a variety of tests and exercises. They sang from the modulator, including chromatic and minor mode passages; gave the notation of sounds sung to them; followed the motions of the teacher's hand representing the scale; illustrated the change of vocal register from the chest to the head voice; and gave examples of the time language of M. Paris. They also sang at first sight, from the Tonic Sol-fa notation, a two-part song, which was simultaneously exhibited on a chart in the ordinary notation to the audience.]

You will be interested to hear a little of the history of the Tonic Sol-fa system.

In the year 1838, my father, the late Mr. John Curwen, made some laborious and very unsatisfactory attempts to teach the children of a Sunday-school, in which he was interested, to sing, by shouting to them the air of a tune at the top of his voice, and enabling them to get it by heart by dint of frequent repetition He saw the shallowness of this method, and tried to give permanence to the work by imparting to the children a knowledge of crotchets and quavers, clefs, flats and sharps, &c., but without result. At this time he was himself unable to read music at sight, and a teacher to whom he went in search of this power, gave him much practice in following his playing at the pianaforte, but no independent power. Some time after, a lady lent him a book on sight singing, by Miss Glover, the daughter of a clergyman at Norwich. He threw this work aside at first, as far more puzzling than the staff notation, but he returned to it afterwards, having again occasion to teach some Sunday-school children to sing. He then read the book, tried its exercises himself, taught them to a child who lived in the same house, and found that they gave him exactly the power of reading music that he wanted. The secret of Miss Glover's little work was that at first it separated music from its signs, and thus allowed the training of the ear to commence, and the signs, all of which were simple, were introduced gradually.

Mr. Curwen was so delighted with this new-found power of reading, and as a minister, he saw such great possibilities of usefulness for the system, in the religious and social offices of music, that he set to work, studying and practising, reading all the best theoretical works he could find. Increased experience made it seem necessary to him to modify and expand Miss Glover's system, in order to render it more popularly useful. The changes ultimately made were so many, that little more than the underlying principle of using the initials of the Sol-fa syllables as the basis of a musical notation, was left. Miss Glover, naturally enough, never approved these alterations, though she did not oppose them. She, indeed, rejoiced in the success of the modified system. Mr. Curwen enjoyed her close friendship until her death, in 1867, at the ripe age of 82.

The plan which Mr. Curwen adopted in spreading the Tonic Sol-fa method, was one that led to its very rapid propagation among the people at large. He did not address himself to artistic coteries, or to the musical profession, but to the clergy, day-school and Sunday-school teachers, temperance and mission workers, amateur choir-masters, &c. He showed that he was in possession of a simple method which almost anyone could teach. He encouraged all who were desirous of cultivating singing to learn a little themselves of the system, and begin teaching it, improving their skill as they went on. Those who took up the system at this time were, almost without exception, men who understood the staff notation, and could sing from it, but who had nevertheless failed to enable children, and the members of their classes, to master it.

The chief events in the history of the system may be briefly stated. Mr. Curwen's first work was issued in 1841, and others in 1843 and 1848. In September, 1850, the first gathering of pupils and friends of the method was held in London. In 1858, the Tonic Sol-fa Association was formed. In 1855, the monthly issue of the *Tonic Sol-fa Reporter* began, and an aggregate meeting of 4,000 pupils of the system was held in London. In the same year, the first attempt to write difficult music in the Tonic Sol-fa notation was made, by the issue of Romberg's "Lay of the Bell." In 1855-6, Mr. Curwen visited Scotland, and the method was soon afterward adopted by the three Presbyterian Churches. In September, 1857, the Tonic Sol-fa Association held the first children's concert on the Handel orchestra at the Crystal Palace. These concerts were continued for many years. Mr. Curwen's first attempt to teach harmony by means of the notation was made in 1862, and after this he spent several years in writing manuals, applying the system to the pianoforte, organ, to stringed instruments, reed instruments, and brass instruments. In 1867, the Tonic Sol-fa Association took part in the International Choral Competition, at Paris, receiving a prize of equality with the first choir, and only being debarred from the first prize because the choir contained ladies' voices. In the same year, at a concert by 4,500 adults at the Crystal Palace, an anthem, composed for the occasion by Prof. Macfarren, was read off at first sight. Prof. Macfarren himself wrote as follows of this performance, in an article published at the time in the *Cornhill Magazine*:—

> "A piece of music, which had been composed for the occasion, and had not until then been seen by human eyes, save those of the writer and the printers, was handed forth to the members of the chorus there present, and then, before an audience, furnished at the same time with copies to test the accuracy of the performance, 4,500 singers sang it at first sight in a manner to fulfil the highest requirements of the severest judges."

In 1868, the Tonic Sol-fa College was founded; its object being to maintain and improve the standard of teaching by issuing certificates, holding conventions of teachers, and training young teachers. It 1869, the Committee of Council on Education, finding that the system had been already adopted very largely in schools, accepted it on an equality with the old notation for use in elementary schools and training colleges. In 1872, the London School Board adopted the system, a step which has since been followed by all the principal School Boards in England and Scotland. In 1872-73, Tonic Sol-fa choirs obtained prizes in public musical competitions at the Crystal Palace. In 1875, the Tonic Sol-fa College was incorporated according to Act of Parliament.

The growth of the number of pupils has been as follows:—In 1856, it was calculated at 20,000; in 1858, at 65,000; in 1872, at 315,000; and now it is, at the very least, 500,000.

The system is, as yet, almost untaught on the Continent, but it has been very much used by missionaries and by English colonists in all parts of the world. It is most extensively used in Madagascar. Tune and anthem books, in considerable numbers, have issued from the native press, in Tonic Sol-fa notation. In Cape Colony a tune book has been printed in Sol-fa letters for the Kaffirs, and the spread of the system among them is remarkable; Dr. Russell, in his letters from Zululand two years ago, bore testimony to the excellent singing of friendly Zulus on this system. A missionary writes that the difficulty is not to teach the tunes, but the hymns; the natives learn to read Sol-fa much more quickly than they can be taught to read their own language. At Hong Kong, a book of songs, and an introduction to the art of singing, have been published in Chinese Tonic Sol-fa. The notation has been applied to Arabic by the European teachers at Beyrout in Syria. When the Crown Prince of Germany was at Mount Lebanon, a band of Arabic Sol-fa children sang "God Save the Queen" to him. In the Fiji Islands the Wesleyan missionaries are using the system. It is taught at many points in India, in Barbadoes, in Trinidad and Jamaica. Among the far-off places it has reached are Japan, St. Helena (where not long since there were five classes), Ceylon, Norfolk Island (inhabited by Pitcairn islanders), and Chili. It is also used by Mr. Armstrong in his evangelistic work in Spain. In the United States and Canada an active propaganda goes on. The system has also been officially adopted by the Governments of New South Wales and Victoria.

In England, the Tonic Sol-fa system is largely employed in reformatories, and mission work of all kinds. It is also used to a remarkable extent in elementary schools. The last Government return shows that out of 5,395 schools in England, Wales, and Scotland, teaching singing by some system or other, 3,987, or nearly three-fourths, use the Tonic Sol-fa.

School music is just now being very much discussed, and I may be pardoned a brief digression on this topic. We may rejoice here with perfect unanimity on the determination of the Government to encourage singing by note in the elementary schools. The teachers are much exercised at having an increase of work without a corresponding increase of grant; but we are not concerned with the financial aspect of the matter, which we must leave them to settle with the Government. Many rash statements have been made in the discussion of the music grant. The fact is, this is not simply a musician's question. The French Government appointed last year a number of the leading musicians in Paris to report on the condition of music teaching in elementary schools, or rather, to lay plans for its future conduct. This group of reports* is interesting and instructive, but it is full of schemes and statements which show a ludicrous ignorance of the possibilities of primary education, and a disproportionate estimate of the time which can be devoted to music in elementary schools. A man must have a practical knowledge of school work and of child life to speak with authority upon the question of school music. I do not think that the proposals to make the music teaching subject to a special inspection, or to hand it over to the Science and Art Department, are at all practical. We advance by steps, and the step we are now taking is a very long one, especially for village schools. The details of the proposed examination in singing by note have not been yet published. They will, I hope, test practice and not theory only. In this respect the suggested standards of Dr. Hullah in the last Education Blue-book, are admirable, though they seem to me to be unnecessarily subdivided, and to be unequal in their gradation.

It is to be hoped that the Training College music course will be made to have a stronger bearing upon school singing than it now has. The rehearsal of classical oratorios, &c., is admirable, as far as it goes, but the students should be made to deliver singing lessons in the practising schools; they should be taught the compass and training of children's voices, and the art of conducting.

To return, however, to the Tonic Sol-fa system. You will notice, from the references I have made, that its uses are largely among the poor and among children, and it is sometimes concluded from this circumstance that there is something in it especially childish or suited to the ignorant. I wish to guard against this supposition. The good and the truth it contains are applicable to all conditions and grades of progress. The distinguished musicians and scientists who have written in favour of the system, have not made any class qualification. Dr. Stainer says:—

> "I believe the Tonic Sol-fa system, as an exposition of the relation of scale sounds, to be the true notation for voices."

Professor Helmholtz, of Berlin says:—

> "During my researches in acoustics, I came from theoretical reasons to the conviction that this was the natural way of learning music."

Sir Robert Stewart, the Professor of Music in the University of Dublin, says:—

> "The Tonic Sol-fa system is better calculated to draw out the intelligence of the pupils than any other with which I am acquainted."

Professor McKendrick, of Glasgow, says:—

> "There cannot be the slightest doubt that the system conforms more to natural methods than any other system."

At this point I refer you to the charts exhibited on the walls, showing our nomenclature of chords and dissonances. Our notation lends itself very readily to the teaching of harmony, as harmony is entirely a matter of key-relationship. To go no further, I may speak of the examination in the theory of music conducted for this Society by Dr. Hullah, as affording incidental proof of the insight into harmony which students trained by our system obtain. The following table shows the proportion of prizes and certificates obtained by Tonic Sol-fa students, in their examinations during six years :—

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* Rapports sur l'Enseignement du Chant dans les Ecoles Primaires. Paris: Imprimerie Nationale, 1881.

Society of Arts Examination in Musical Theory.

Prizes granted, 13. Of these, 10 were gained by Sol-faists.

Certificates granted, 698. Of these, 415 were gained by Sol-faists.

The Society, of course, has no official knowledge of these figures, which are obtained from private sources. Nor is the examiner aware by what system the candidates are trained.

It is very important that you should understand the connection between the Tonic Sol-fa notation and the ordinary staff notation. At first sight, it seems as if the one had no bearing upon the other; as if they were distinct languages. They are not, however, two languages; they are two alphabets of the same language. Hence, to pass from one to the other is an easy matter. It is constantly being asserted that all the time spent upon our system is thrown away when the pupil wants to learn the old notation. We are charged also with endeavouring to supersede the old notation. Both assertions are wholly incorrect. All the time and study spent upon our notation has a direct bearing upon the old notation. I am going to prove this by an experiment upon the boys before you.

[Mr. Curwen explained that on visiting the school for the first time on Monday, he found that the boys knew nothing whatever of the staff notation. He gave them a short explanation of the staff and of notes, and made them sing a few exercises from the blackboard. This explanation and practice lasted five minutes. He would now test their power of singing at sight from the staff notation. A hymn-tune by Crüger, in the key of G flat (six flats), was then suddenly presented to them, and they sang it off correctly at sight.]

Opponents of our system, in hearing of an experiment of this sort, exclaim, "Just so; that shows how easy the old notation is." But you will all clearly see that it is the preparatory training which these boys have had, not the easiness of the staff notation, which makes them pass this test. They have formed the habit of seeing the key-relationship of sounds. This habit formed, they carry it with them to the staff notation. When they look at the staff, they see in their mind's eye the modulator; and each bar is divided into pulses by imaginary accent marks. All this is a key, and gives great certainty. These boys are staff notationists of but five minutes standing, yet they can already do what many persons who have devoted years to the practice of music have to call in the help of a pianoforte to accomplish. It has been recently asserted by several writers that our system is unfair to the poor, and places them at a disadvantage, as compared with the rich. I invite you, ladies and gentlemen, to commiserate these boys on their disadvantages, and upon the cramping influences of musical sectarianism which surround them.

It may, however, be asked, why not begin with the staff notation if you ultimately work round to it? I am by no means insensible to the many practical inconveniences of having two notations of music. If we, as Tonic Sol-faists, found that we could do our work with the staff notation, we would give up our letters to-morrow. There are strong forces always at work urging us to do so—the dislike of being singular, the magnetic influence of orthodoxy, respectability, and antiquity. Against these forces work the still stronger ones of our educational consciences as teachers, of the evidence of the need of our notation daily renewed in our work, of the perfect way in which our notation fits our method, and allows us when we talk of *doh* to write it down.

I need hardly say that we find among our pupils a laudable ambition, which we do our best to encourage, to learn the staff notation. Out of 7,400 who recently took certificates on our system, 5,081, or close upon two-thirds, passed an additional examination in sight-singing from the staff. Mr. Ebenezer Prout, the well-known critic and composer says :—

"My own experience is that Tonic Sol-faists, when they have once mastered the ordinary notation, are amongst the safest readers of music."

Dr. Stainer says :—

"The time bestowed on the study of arithmetic is not lost to the student of algebra; nor will the time given to letter notation be thrown away if the staff notation be afterwards mastered."

Mr. Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge, says, on this point:—

"The established notation is encumbered by a mass of difficulties exclusively due to the misleading system of 'natural' and 'altered' scales on which it is built. On the principle of teaching no superfluities to beginners, it is therefore advisable to provide a subsidiary notation, presenting no other difficulties than are inherent in music itself. When these have been mastered, and not till then, the learner will be in a position to understand what the additional difficulties of the staff notation arise from, and to grasp the meaning of that system with a thoroughness which, but for which preliminary training, he would only attain with far greater effort. For this reason, I should advise that even children who are to receive the most complete musical education should be well grounded in the Tonic system before they are set to decipher the conventional complexities of the staff. That the first musical instruction to the children of the poor should be given on the Tonic Sol-fa system is to my mind axiomatic. Even if they never proceed further they will have obtained the means of high and enobling musical enjoyment. I think, however, that those who control the music-teaching in our elementary schools should organise a course of instruction including both Tonic and the established notations."

I cordially agree in principle with Mr. Sedley Taylor's wish that the staff notation should come at the end of the school course. At present, I do not advocate it, because I am assured by teachers, and by my own observation, that the introduction of the staff notation, even in the higher standards of our elementary schools, would mean that the Tonic Sol-fa course could not be completed. The minor mode and chromatics would have to be dropped in favour of the staff symbols. This would be highly undesirable. Experience and time may —and I hope will—modify this opinion. When Tonic Sol-faists see that the schools have so advanced in singing that the staff notation can be introduced without sacrificing the educational thoroughness of their system, you may be sure they will advocate it warmly.

The simplicity of our system is generally admitted by our opponents; but its easiness is a fault in the eyes of some. They describe it as a "royal road," and as "inferior as a mental exercise to the staff notation." A royal road is a method of procedure which is deficient in thoroughness and permanence; which obtains present speed at the cost of future interruption and disappointment. I hope the experiments you have seen to-night have convinced you that our system does not do that. As to its being inferior as a mental exercise to the staff notation, it is enough to say that mere difficulty is no merit. To say that Tuesday should mean Wednesday would be a superior mental exercise to the ordinary plan, but it would be useless. The mental exercise which our system gives is proved to be, musically, most bracing and formative when the troubles of the staff notation have to be encountered.

It may be asked whether the Tonic Sol-fa notation can be used for instruments—can be played from as well as sung from. To that I reply that there are at the present moment hundreds of players, especially of the organ and harmonium, using it. It is also used to some extent by brass bands and for the violin. One advantage which the player from this notation possesses, is the facility of transposing his music into any key. When accompanying voices this is a great advantage. I do not myself consider that we have yet had enough experience of the use of our notation for instruments to justify us in speaking as strongly of its superiority in this as we do of its superiority in the vocal department. Nor do I feel the point to be of such great importance. The minority only learn to play, and the learning of an instrument is more a question of fingers than of notes. Besides, as Dr. Hullah has so often and so wisely remarked, all musical education, whether of players or of singers, should begin with singing; the eye and ear should be first trained by the exercise of the voice. The teaching of singing, therefore, is of universal and paramount importance.

It may be, and often is urged, that no great singers or composers use this notation. This is begging the question. There are very few great singers or composers, but there are hosts of people of moderate musical capacity in all classes who are anxious to come to a clear and self-reliant command of musical notation, and who, under the existing *regime*, do not do so. The great singers can take care of themselves. They will learn on any system, and on no system. The true educationist looks beyond them, and provides for the great majority.

Let me remind you, in conclusion, that the problem of English musical advancement will not be settled by the establishment of a Royal College of Music. That scheme is in every way an admirable one. My position, as President of the Tonic Sol-fa College, leads me to be constantly roaming the country, and listening to the singing in elementary schools, and among the people in general. I occasionally hear voices of remarkable promise, and it is a national reproach that hitherto there has been no means of taking rich voices and training them, instead of allowing them to be wasted for want of cultivation. If the Royal College of Music will do this, it will earn the gratitude of us all. But the training of 100 executants will not make England a musical country. The people must be trained to meet and to appreciate the native talent which we hope, in a few years, will delight them. This can only be accomplished by such popular movements as that in which we Tonic Sol-faists are engaged. We are working for national objects, and we have a right to claim the sympathies of all who value the religious, the social, the artistic, and the educational values of music.

APPENDIX.

At the request of the Irish Commissioners of National Education, a public trial of the Tonic Sol-fa system was held in Marlborough-street Schools, on the 7th inst. Sir Robert Stewart, Mus. D., University Professor of Music at Dublin, has written the following statement in reference to this trial:—

"59, Merrion-square, March 16th.

"Having been requested to witness the results of three months' teaching of classes at the National Schools, on the Tonic Sol-fa plan, I proceeded thither on the 7th inst. It appeared that the classes had not been divided into sections after the customary method pursued in the Tonic Sol-fa system, but had been taken *en masse*, just as they came. They had received three lessons of half an hour each per week. Thus the system was not tried with the full advantages of its organisation, the teacher being anxious to give Tonic Sol-fa a chance, which for various reasons it never had been previously afforded in these schools, where the Hullah system has held the ground since the schools were established in Ireland. Even with this drawback, the results were very satisfactory. The children read both the tests from the modulator and from manual signs, singing harmony in two parts from the latter with great accuracy. In order further to show that the class were able to use the staff notation (which under ordinary circumstances would certainly have not been introduced in a three months' course), they sang from the blackboard. And although the signature was repeatedly changed by the teacher, with the view to show that they could sing equally well in any key, they were fully equal to the test, and acquitted themselves remarkably well. They sang at sight test melodies written by Dr. Joyce of the National Schools, and by myself; and I fully tested them by the pointer in their powers of reading from the modulator. Judging from what is usually learned in three months, I must say I thought the progress of these children very remarkable, even in that department in which those that are averse to the system insist so frequently that it is valueless—namely, in reading from the old notation. Their intelligent grasp of the lines, spaces, and semitones was most creditable alike to the system of Tonic Sol-fa and to Mr. Cowley, who had trained this large class of children to an intelligent appreciation of both systems.

"ROBERT P. STEWART."

DISCUSSION.

The CHAIRMAN, in inviting discussion, said it would be interesting to hear something on the other side of the question, and if anyone had any objections to urge against this system, he should be glad to hear them.

Mr. JOHNSON said he had great faith in the Tonic Sol-fa system, but he thought it was rather misleading to compare it with Hullah's. There was a difference between the Tonic Sol-fa system and the old notation, but anyone could learn the old notation in a week, though it did not follow because the boys had sung a tune in the old notation that they had learned it; there was a good deal more to learn after that. The Tonic Sol-fa system could be combined with the old notation, but Dr. Hullah's system could not; in that system the *Do* was kept fixed; the key-note was *Do* in the key of C, but in the key of G it was *Sol*, and therefore there was a great difference. In his opinion the best method was to combine the Tonic Sol-fa system with the old notation. There was, no doubt, a great advantage in the Tonic Sol-fa system, that the printing of music in it was much cheaper, and there was no doubt it was the true system of learning to sing, but it might usefully be combined with the old notation.

Mr. THEODORE CARTER said he thought the last speaker was a little confusing systems of teaching and systems of printing, but he would leave that point, and simply state his own experience. He was totally unconnected with any school system beyond being a member of a School Board in the suburbs; but he was an old pupil of Mr. Hullah's, and also of the Tonic Sol-fa system. As a young man he joined Mr. Hullah's classes at St. Martin's-hall, beginning at the bottom, and remained five years; the students got on very well through the first part of the book, where they were always singing in the key of C; but directly they got into the second part, amongst the sharps and flats, they were all floundering about, and did not know where they were at all. He ultimately went into the first class, which sang choruses from the oratorios, but he still found a difficulty in reading music; he then took some lessons from a German gentleman who taught by means of figures, but still did not reach what he wanted, to be able to sing at sight. He then heard of the Tonic Sol-fa system, and took about twelve lessons, and there, at length, he found what he wanted—facility in reading ordinary music at sight. He followed up this for some time, and had his certificate of competency dated December, 1856. He had not done much in it since, but had had several opportunities of teaching classes of amateurs, and had always based his teaching on the Tonic Sol-fa combined with the use of the staff. He had the pleasure once, when in Mr. Hullah's class, of going to Paris, with an introduction from Mr. Hullah to a Society of Orpheonists, and there he had an opportunity of noticing the laborious manner in which tunes were drummed into the ears of the pupils before they were able to sing them. About 1869, when he was a member of the Rev. Mr. Fleming's church at Peckham, that gentleman being desirous of introducing the Tonic Sol-fa system into the school, asked for his help. The schoolmaster, after receiving three lessons, began teaching; he went on for a short time, keeping just three lessons ahead of his scholars, and then he (Mr. Carter) sent him to a professional man for further instruction. When the London School Board introduced the Tonic Sol-fa system into its schools, the Rev. Mr. Fleming congratulated himself very much that he had been beforehand with them. In conducting private choral classes, whenever a difficult passage was met with, he (Mr. Carter) had always found the easiest way to get over it was to explain shortly the Tonic Sol-fa system, and sing it over by the modulator. He had the modulator hanging up in his childrens' school-room, and taught them to sing easy tunes from it; and, as they grew older, he intended them to learn the system thoroughly, combining it with their other musical education. From his experience, extending over a long series of years, he should say to any one who wanted to acquire the power of singing at sight, learn the Tonic Sol-fa system, and if they knew the old staff notation, so much the better; the one did not interfere with the other. He did not wish to depreciate his old teachers, Dr. Hullah and Dr. Monk, of King's College, but notwithstanding all they had done, he was quite satisfied that the Tonic Sol-fa system had done much more, and had turned out hundreds and thousands of sight-singers.

Mr. JAMES THOMSON, being called upon to speak said he was quite unprepared to do so, but he would narrate a short anecdote from his own experience. Not long ago he went into a school, a high class school it was called, where the boys had begun to learn this system. It appeared, however, that some of the parents objected, saying their boys had learned the old notation, some of them for years, and they did not like them being put back, as they called it, to the Tonic Sol-fa. He asked the master to let him try if the boys could read from the old notation, because if they could, there was no reason why they should not go on. He wrote on the blackboard about as simple a chant, in the key of C, as he could think of, and tried each boy separately, first asking how long they had been learning, and finding some had been at it a year and a-half, some a year, some two years, and so on. Their attempts to sing it were most lamentable failures, until be got nearly to the end, and then he found one boy who sang it through without a mistake. He then changed the key and gave him something more difficult, which he also sang correctly, and he only broke down when tried with something very difficult indeed. On inquiry, he found, as he expected, that this boy, the only one who could really read music at all, had learned the Tonic Sol-fa system.

Mr. McNAUGHT said they were sometimes told that the same results could be obtained from the old notation if properly taught, and that this system was not taught on the Continent, which was true; but the fact was also true, as appeared from Dr. Hullah's report, that the teaching of sight singing was being almost abandoned in the schools in Germany. He had visited Holland, and examined many schools, and would give the result of the best school he went to. It was divided into seven classes; in the first, or lowest, the children sang only by ear, about 2½ hours per week; two half-hours they sang songs with the second class, and the rest by themselves. The second class had two hours a week, two half-hours with the first class, and two half-hours reading notes. The third and fourth classes had each two half-hours for studying facts and notations, and two half-hours for songs for one or two voices. The fifth class had two lessons a week, each of three-quarters of an hour, and one of half an hour; and the sixth and seventh classes had 1½ hours for studying songs for two or three voices. The result was thus described by the teacher. "Perhaps after some time when the same method of teaching (that of the fixed *Do*) has been long enough made use of to reach the sixth and seventh classes, we may extend the programme of exercises over a greater part of the musical theory; as yet most of the songs with more than two flats or sharps in the scale, are transposed into other ones to facilitate the reading of them."

The CHAIRMAN said it seemed rather a pity they had not heard the system more strongly attacked. It had many opponents, and it would have been more satisfactory if they had heard what was to be said against it, and the answer which Mr. Curwen had to give his opponents. It was true that he had by anticipation answered many objections which naturally arose in the mind of the general public, the most obvious of which was its alleged interference with the staff notation. If it were really the fact that any difficulty was thrown in the way of a student going on to the staff notation, it would be a very serious objection; and for himself, he must say he thought the teaching of elementary music to a large number of school children would be an advantage dearly purchased, if it were at the expense of quashing some young musical genius who might have struggled to the front, but who had been stopped or checked by the system. But, happily, there seemed no reason to believe that this was the case, though he should have liked to have heard a little more about it. Mr. Curwen had brought forward a pertinent example in the Society of Arts examinations, as to which he had only to say that he had no knowledge whatever of the figures quoted, but he was quite certain that Mr. Curwen would not have quoted them unless they had been accurate. It would be understood that they were put forward from information which was not available to any officer of the Society. The candidates came up, and neither the examiners, nor any one connected with the Society, knew how they had been taught. It had often struck him that the system of teaching to read from notes in England was very defective, much more so than that which obtained abroad at all events in France. He had some French friends who were accomplished musicians, and he had heard them remark on the want of this teaching in English classes, and compare it with the way in which French children were taught to write down music which was sung or played to them; but this defect evidently did not attach to the Tonic Sol-fa system. On the question whether those trained in the staff notation could read music with equal ease, he might give a little evidence. For some two or three years the Society of Arts had held practical examinations in music, a portion of which included calling on the candidate to play or sing at sight; and he must say that the children who were there that evening sung much better at sight than at all events a considerable portion of the candidates who came up, and who had had a considerable amount of musical education. Mr. Curwen had raised rather a curious point as to the pianoforte having had a detrimental effect upon singing; and it struck him that the increase of instrumental music might have something to do with the decrease of singing in England. One heard that in the sixteenth and seventeenth centuries the accomplishment of part-singing was much more general than now; almost everyone could take part in a song, and it would be an interesting subject for inquiry how far the piano was answerable for the falling off in singing. One important point was that although there was a great deal of objection to this system on the part of musicians, yet it was supported by those men of science who paid special attention to acoustics. The greatest living writer on this subject, Helmholtz, referred in terms of praise to the Tonic Sol-fa as being a natural system, and he had been followed by men like Mr. Sedley Taylor, and others of the same class. He should like to hear from Mr. Curwen if it had made no progress in any country except England and her colonies and dependencies, because this was a great drawback as compared with the universal acceptance of the ordinary musical notation.

Mr. CURWEN said with reference to the Chairman's remark about the non-recognition of this system on the Continent, he would say that it had not spread there, because it had never been introduced; he hoped before long to make an effort in that direction. He had already endeavoured to explain that their principle was not to supersede the old notation; there were a certain number of pupils who never got beyond the Tonic Sol-fa notation, but all the more intelligent went on and became familiar with the intervals on the staff.

Mr. T. R. WRIGHT remarked that there was a system in use in France—the Galin-Paris-Chevel, which was identical in principle, though not in all its details, with the Tonic Sol-fa; he did not know how far its introduction might account for the superiority in sight-reading which had been mentioned by the Chairman.

Mr. GLOVER added that he went to Paris in 1867, with some Tonic Sol-faists, when they met a number of pupils of the system just referred to. The signs consisted of figures and dots, and the Tonic Sol-faists were able to sing from them. This showed that there was a craving for some other notation than the ordinary, and he had been informed that even in Russia there were teachers using a system of figures. There was no doubt, therefore, that there was a growing feeling on the Continent in favour of some Tonic Sol-fa system, although it had not yet attained the dimensions which the Tonic Sol-fa had in this country.

After some further illustrations of part singing had been given by the boys,

The CHAIRMAN moved a hearty vote of thanks to Mr. Curwen for his extremely interesting and lucid paper, and asked the meeting to include in it the schoolboys who had given such valuable assistance in illustrating the merits of the system.

The vote of thanks was carried unanimously, and briefly acknowledged by Mr. Curwen.

Miscellaneous.

ELECTRICAL PATENTS.

The following statistics relating to the patents taken out for improvements in the practical application of electricity have been supplied by Messrs. Fahie and Son, 323, High Holborn, and Dublin :—

During the year 1881, it appears that no less than 237 applications for patents have been recorded at the Patent-office, for inventions which may be classed under the heading of electricity; of this total, 135 emanate from British applicants, 52 from American citizens, and 50 from residents on the Continent. Classifying the total number of 237 applicants under special heads, it appears that 93 specifications have been lodged for improvements in electric arc lamps, 20 for improvements in incandescent lamps, 38 for magneto and dynamo machines, 32 for secondary batteries or electric accumulators, 26 for regulating, controlling, and measuring the electric current, 24 for miscellaneous appliances connected with electric lighting, and 4 for producing power and transmitting motion. Reviewing the names of the applicants for above patents, it appears that the American inventor Edison stands highest on the list, having applied for no less than 24 patents for various electrical improvements; Messrs. Swan and Lane Fox each filed 7 applications for improvements, mostly in connection with incandescent lighting; M. Faure, of Paris, 3 for secondary batteries; while Maxim filed 2, and Brush 1, for arc lighting apparatus.

ON THE PRESENCE OF GREASE IN STEAM BOILER DEPOSITS.

By Thomas T. B. Bruce Warren,

Professor of Chemical Technology, Silvertown Institution; Analytical Chemist to the India-rubber, Gutta-percha, and Telegraph Works Company, Limited, Silvertown.

I have so frequently met with experienced chemists who deny the possibility of grease being present in the deposits from steam boilers, that I venture to offer the following remarks on the subject:—

Some time ago a friend requested me to examine a sample of feed water for grease, assuring me at the same time that an action taking place on his boilers. had led to the inference that the water contained grease. The feed water was heated with exhaust steam from an engine. On carefully testing the water, it was found free from smell and taste, and did not affect the rotation of pieces of camphor when thrown into it. On heating the water no smell was perceptible.

A portion of the deposit itself from the water was submitted to analysis, with the following results, when carefully dried at 220° F. and dissolved in hydrochloric acid:—

Soluble solids	92·71
Insoluble	7·29
	100·00

The soluble solids consisted principally of calcium, magnesium, sodium, iron, and silica, with carbonic, sulphuric, and phosphoric acids. The insoluble portion was dried again on the filter after careful washing. Carbon disulphide was poured over the residue, and the collected filtrate evaporated. Not the slightest residuum was obtained, even when the insoluble portion from 500 grammes of deposit was operated on.

My friend was so certain that grease was probably present, that I felt great reluctance in giving an opinion until I had exhausted the subject by a very extended examination, when I decided that no grease was present.

A little time afterwards, I received a sample of deposit said to have been collected from the top of the water, after the steam was blown off. A portion of this was treated in exactly the same way, and I was surprised to find that without any difficulty at all, I could recover 3·78 per cent. of solid fat. I have no doubt that the reason why it was not found in the deposit from the bottom of the boiler, is, that an insoluble earthy soap was formed in the boiler, which floated on the surface of the water in the same way as the scum which is formed when using soap with hard water.

The injury to a boiler, where such water is used, results from a portion of this earthy soap coming in contact with the heated junctions of the joints and rivets, where, by keeping off the water, the parts become more strongly heated, the soap then becomes charred or burnt, when the water again comes in contact with the strongly heated metal, producing alternate rapid expansions and contractions.

That leakage from this cause does very frequently take place, is unquestionable; but it is very evident that the matter is not so generally known as its importance deserves that it should be. The fact that no grease was found in the deposit from the bottom of the boiler gives support to the idea of its being destroyed by contact with the heated metal surface.

SUGAR IN CHINA.

From a report recently issued by the United States Consul at Canton, it appears that the cultivation of the sugar-cane, and the manufacture of sugar in China, is at the present moment attracting considerable attention among the inhabitants of the Celestial Empire, and statistics, published by the Inspector-General of Customs at Shanghai, show a considerable increase, of late years, in the export of sugar to foreign countries. The following method of cultivating the sugar-cane is employed by the Chinese. When the cane is cut down, the tops are removed, and bound in bundles, and the leaves of these top cuttings are taken off; the cuttings themselves, which usually have four or five joints, are placed in a pond of fresh water, where they remain in soak for some twenty days; at the expiration of this time the joints will have thrown out sprouts or buds, these sprouts are about four or five inches in length; the cuttings are then planted in rows, about two feet apart, and at an angle of about 60 deg. The cuttings, when planted, are slightly manured with bean cake, composed of compressed pulp of the yellow China bean, which grows abundantly in the northern portion of the Empire. It requires ten months, from time of planting, before the crop is matured and ready for harvesting. From the roots of this crop being well-fertilised with the bean cake in a semi-liquid form, a second crop is produced; even a third is sometimes secured in this manner, but this is only when the soil is exceptionally rich. If the soil is not sufficiently fertile for a third crop, the roots are removed, the land cultivated and manured as for the first crop, and cuttings are planted every two years.

The cane, when cut, is collected in bundles, and conveyed by men or boats, according to locality, to the mill or crusher; this consists of two granite cylinders about three feet in length by eighteen inches in diameter, placed perpendicularly, the lower ends revolving in a stone socket, the upper in a frame of wood set into granite uprights; attached to or let into the upper end of these cylinders, are wooden cogs, and to the end of one of these cylinders is attached a strong wooden shaft or spindle, to the upper end of which is fixed a strong cross beam or lever, and to the outer end is attached the propelling power, which usually consists of four or five small oxen. The cane is passed between the cylinders, the juice running down into a small trench, which opens into a receptacle in the ground holding about 20 or 30 gallons; the juice is then conveyed in buckets to the boiling pans near at hand, and the cane, after being crushed, is taken away to be used as fodder. It is sometimes dried in the sun, and is used for fuel for boiling the sugar. The boiling-pans are of cast-iron, the greater part of those used being made at Fat Shan, about 15 miles from Canton. They are about eighteen inches deep by four feet in diameter, and are placed in brickwork side by side, usually four in number, with arches for fuel underneath, all covered with a mat or thatched shed. Three kinds of sugar are manufactured, viz. "rock-candy," "green sugar," and "clayed sugar." The rock-candy is made as follows:—The sugar is placed with a sufficient quantity of water in a large boiling-pan, similar to the ones already described, and boiled down to the proper consistency, which is ascertained by putting a small quantity into cold water; if it hardens at once, it is then time to run it off into earthen jars—these jars holding about 50 lbs. each. They are always broken in three or four parts, and the parts are then bound together with a small quantity of lime cement and a few bamboo or rattan hoops. The hot liquid is then put into these broken jars, and a network of basket-splints is placed over each, the ends of the splints extending in different directions through the liquid to the bottom of the jar. If the temperature is cold, it will crystallise in about fifteen days; if warm, it requires from twenty-five to thirty days. As it crystallises it adheres to the splints, the portion not crystallising settling at the bottom. The jars are then placed with the bottom part turned partly up over empty ones to allow the molasses to run out. When sufficiently drained, the jars are removed, the hoops taken off, and with a small hatchet the parts again broken asunder; the candy is then removed from the splints and spread out in the sun for a short time to purify or bleach. It is then assorted and packed into wooden tubs holding from 40 to 50 lbs. each.

Two qualities are always found in the jars; that at the bottom being darker and of less market value. The drainage from these jars is re-boiled, and a poorer quality of brown sugar produced; from the refuse remaining after this last process a cement is made by mixing with lime. The process pursued in the manufacture of "green" sugar is as follows:—The juice is boiled in the month of December, as it is taken from the crushers in buckets in one of the four iron boiling pans; a man is in attendance who pours the juice from one pan to the other. As soon as the liquid boils, a small portion of lime is put in, and the white of one or two eggs is placed in each pan. After a time the dirt and refuse come on the surface, which is all skimmed off from time to time, while the sugar is boiling. When sufficiently boiled, it is run off into a wooden cooler, about seven feet long, four feet wide, and one foot deep; and while in the hot liquid state, a man begins to stir it about with a piece of wood about a foot-and-a-half long, and an inch thick, attached in the centre to a handle about four feet long. With this wooden instrument the liquid is kept in constant motion, until it begins to granulate and cool, and when cool enough, several men mix and rub it with their hands until all the lumps are bruised and the sugar becomes all of one colour, which is a dark yellow. It is then put in baskets, and sold to sugar dealers, who put it up in mat bags, and bring it to markets for sale to merchants for shipment. The sugar principally exported to foreign countries, is what is known as "clayed" sugar, and is made as follows:—When the juice is boiled to a proper consistency, the whites of two eggs are put into each pan, which serves as a clarifier; when sufficiently boiled, it is run off into conical-shaped earthenware jars, which are placed in rows either over trenches or empty jars. In the bottom of each jar containing the sugar is a small aperture in which is placed a wisp or bung of straw; when the sugar has become sufficiently granulated by cooking and an occasional stirring, the straw bung is slightly loosened, the portion not becoming sugar escaping into the trench or empty jars. When sufficiently drained, a thin layer of straw is placed over the sugar, and over this a thick layer of clay. The jars are then packed away in a dry place where they remain from thirty to forty days, according to the state of temperature. The coverings and straw bungs are then removed, and each jar will be found to contain three qualities or grades of sugar, the upper part being white, the next light brown, and at the bottom a dark brown. The drainings are sometimes used for distilling purposes, and also for making cement. It appears that two distinct kinds of cane are grown in China, one being of a dark purple colour, and this is better for sugar than the other, which is green, and quite tender; the latter is principally sold in pieces about eight inches to ten inches in length, to the natives, who eat it in its raw state.

Correspondence.

BLOOD-POISONING AND BAD DRAINAGE.

The banishment of the Duchess of Connaught from Bagshot-park, occasioned by causes so clearly described by Dr. William Playfair in his report printed and published on the 17th of March, is a disgrace to the sense and civilisation of England. Can nothing be done to impress every dweller in a house, be it a palace or a cottage, that he is always breathing living germs of disease if the drainage of his house is defective? The Prince Consort died of typhoid fever conveyed through faulty drains. The Prince of Wales was brought very near to death's door by the same causes, and now we have a young and Royal mother attacked by the results of bad drainage. The papers told us last week that the Bishop of Peterborough is obliged to quit his palace on account of its unhealthiness. A short time ago the late Dean of Westminster died of blood-poisoning in his house at Westminster—a site to which the boarding-houses of a great school persistently cling as healthy and profitable to individuals. The metropolis has spent four millions of pounds sterling to construct its main sewers, with which it will be proved some day that not half the houses in London are connected. Soon after Mr. Gladstone went to live in Harley-street, some forty houses in that street were found to filter into the soil direct, and to make no use of the sewers. Within two years past, such palaces as Stafford-house, and Spencer-house, &c., made no proper use of these sewers; and defective drainage is proved by constant illness in districts like South Kensington, where houses are leased at rentals of hundreds of pounds a year. And what is to be said of the drainage of the new Government offices in Whitehall? Where can we look for protection against these germs of death, invisible to ordinary mortals, but known to the man of science? I pray you allow me a little space for a few suggestions:—(*a*) Let there be appointed immediately a Joint Committee of Lords and Commons simply to inquire into how many houses in London can be proved to be disconnected with the main drainage. It is not an inquiry for the Metropolitan Board of Works, which can only administer the existing defective law. (*b*) Let the Education Department, in the fourteen thousand schools under its inspection, direct the managers of them to produce an accurate account of the state of the drainage and the ventilation of those schools. Cause the words "Rules of Health," which are to be found in the new Code, to be properly understood and practised in all schools, and be made a compulsory subject for instruction. Slow as the process may be, the remedy against blood-poisoning by bad drainage and imperfect ventilation, is only to be obtained from the better instruction of the people.

I have been engaged for the last four months in organising measures of protection against diseases generated by blood-poisoning, and hope to see a centre watchfulness established in every parish in the kingdom, by means of which the public at large should do its own work of precaution, and not rely on public authorities solely. I propose to call these centres of watchfulness and sanitary action, "Parish Guilds of Health;" and it is not money, but a common sense of danger, with benevolence, that are required for the management of them. I have sought for the support of all the sanitary societies existing in the metropolis, and I have received it from members and officers of the National Health Society, the Sanitary Institution of Great Britain, the Sanitary Insurance Association, and the London Sanitary Protection Association. The Society of Arts has held conferences since 1876 on the health and sewage of towns; national water supply, sewage and health in 1879; and on the progress of public health in 1880, and will shortly hold a meeting to discuss these Guilds of Health, and I appeal to the public press to help on this national movement.

HENRY COLE.

96, Philbeach-gardens, S.W., March 18.

MODERN ORDNANCE.

My attention has been attracted to the paper on "Modern Ordnance," read by Colonel Maitland, R.A., at the meeting of the Society of Arts on the 8th ult., in which that officer explains the advantages in uniform velocities, and flatness of trajectory obtained by the use of the slow burning powder lately introduced into the services. In the discussion which followed on this, and in which Sir John Adye, Surveyor-General of Ordnance, took part, Professor Abel, the chemist of the War Department, referring to "the improvements affected in the manufacture of gunpowder," said, "that great attention had been paid to means for regulating its density and hardness, and the size of the individual masses, &c.," and Colonel Maitland, in reply on the discussion, stated, that "it was said that retardation for regulating the consumption of powder was old; but it was so new that until a few days ago it was not believed in," &c.

With reference to the foregoing, I beg to submit the enclosed Specification of Patent No. 3,286, granted to John B. O'Hea and William Bullen, on the 27th October, 1868, for improvements in breech loading ordnance and their cartridges, &c., by which it will be seen that one of the chief objects of the invention so patented was "to graduate and control, to a certain extent, a too rapid combustion of the powder charge." (See Specification, page 7.) Further, the letter from Messrs. John Hall & Son, the well-known gunpowder manufacturers—which I also enclose—will show that, prior to June, 1874, they manufactured for me large grained powder of *extra density* and *hardness*, to enable me to carry out further experiments having the object of controlling a too rapid combustion of the powder, in ordnance as well as small arms.

When Colonel Maitland wrote his paper, he may not have been aware of the existence of this patent, or that the matter had not been experimented upon nearly fourteen years ago, although on completing the patent, and after having practically satisfied myself and friends of the correctness and value of the invention, a copy of the specification was forwarded to the War-office and to the Ordnance authorities.

However, I now deem it a duty to myself and to the memory of my friend Mr. Bullen, to bring the matter to the notice of the Society of Arts, feeling confident that they will accord me a recognition of the facts as above stated.

I should have been present at the meeting of the 8th ultimo, had I known the paper on "Modern Ordnance" was to be read.

John B. O'Hea,
Late Captain 25th Regt. K.O.R.

March 10, 1882.

PUMICE-STONE.

In a recent number of the *Journal* (pp. 398-9) there was rather a long note on the pumice-stone produced in the Island of Lipari. No hint was given as to the purposes which render it an important article of export, nor was indication given of the uses to which it is or may be applied on the large scale in this country. Perhaps I am right in assuming that this waste product of extinct volcanoes is often found very serviceable in the construction of docks, piers, and other heavy masonry works exposed to the action of the sea. This being so, it may be worth while to direct the attention of engineers and contractors to a deposit of pumice-stone, which, though geographically more remote than Lipari, must be more readily available for British purchasers. It is to Aden that I refer—that volcanic promontory so politically important as an outwork of our Indian Empire, though often unduly execrated as a place of residence by the military and civil servants of the Indian Government, who have to take their turn either in the "crater" or on the "Rock." In and around that unblest Eden, there are, I believe, thousands on thousands of tons of lava deposits from which pumice-stone can be and is prepared as described in Messrs. Toso and Baldacci's note on Lipari. It was during the construction of the Prince's Dock, Bombay—the second wet dock ever constructed east of Suez—that the value of this volcanic product from Aden was brought to my notice by the engineers of that work, who were utilising it largely as an essential portion of the hydraulic mortar and cement for the dock foundations and walls. For this purpose the pumice-stone was, I understood, found peculiarly serviceable. Mr. Thomas Ormiston, M.I.C.E., consulting engineer to the Bombay Port Trust, and designer of the dock, who is now in England, could give full technical explanations as to the right use of this lava stuff for sea-masonry work.

My object is to point out how easily this material can be brought to England, if there be any such demand for it as is implied by the price (£40 per ton) said to be obtained for the best Lipari pumice-stone delivered at Messina. Whenever steam tonnage happens to be in excess in the India ports, charterers would be able to fill up with this article at Aden, where, I feel sure, the cost on board would be far less than that of all but the lowest of your quotations from Sicily. If inconvenient to bring pumice-stone on the top of other cargoes, vessels coming from Bombay might arrange to obtain it there, and stow it below cotton, seeds, or wheat. It was brought from Aden to Bombay for the dock works by country craft at a very low rate per ton; so that it might even be brought to England at as little freight all the way from Bombay—where there is often surplus tonnage—as from Sicily where the amount of shipping available must be scanty and uncertain.

W. Martin Wood.

West Kensington, March 8th.

Notes on Books.

Report of the Lightning-rod Conference. Edited by J. S. Symons, F.R.S. 1881.

In 1878, at the instance of the Meteorological Society, a committee was formed of representatives from that society, from the Institute of British Architects, the Society of Telegraph Engineers, and the Physical Society, in order to consider the question of the protection of property from damage by electricity, and the preparation of a code of rules for the erection of lightning conductors. The report of this committee has just been issued. It gives an account of the considerations which should be attended to in the erection of lightning conductors; their size, shape, character, method of attachment, earth connections, &c. These considerations are embodied in a code of rules for the erection of lightning conductors comprising the various matters which should be attended to in drawing out a specification for a lightning conductor. The report itself forms but a small portion of the book, the greater part of which consists of a number of appendices. These comprise, besides the various documents used in the investigations of the committee, abstracts of various papers, reports, and other documents bearing upon the subject.

Turning and Mechanical Manipulation. Vol. iv. By J. J. Holtzapffel. London: Holtzapffel & Co., 1881.

It has always been a source of regret to those interested, especially as amateurs, in turning, that the late Mr. Holtzapffel died before the completion of the well-known work which he projected under the above title. The original work increased so much in its proportions during the course of its preparation, that the author died before he had actually reached the main subject of the work—the lathe. The three vols., two of which were issued during his lifetime, and one shortly after his death, were devoted to the materials used in mechanical manipulation and their treatment, and the application and use of hand tools. Some materials had already been collected for the completion of the work, but this was in far too incomplete state to allow of its publication. In 1879, the author's son, Mr. J. J. Holtzapffel, brought out a fourth volume of the work, and this, last year, reached a second edition. This volume relates to the principles and practice of hand or simple turning, and, it is announced, is to be followed by two other volumes, of which vol. v. is to deal with ornamental turning, while vol. vi. is to be devoted to the principles and practice of amateur mechanical engineering. The first portion of this fourth volume is historical. A full account is given of the various early lathes, the origin of which is quite lost in antiquity. Probably the potter's wheel was the first apparatus of this clsss; but whether this is so or not, is merely conjectural. The form which the lathe now takes it only reached at the end of the 17th century. That appears to have been the time when first a continuous rotary motion was given to a lathe by means of a treadle. Passing on from this historical portion, we come to the modern foot-lathe. Mr. Holtzapffel describes the various classes of these, from the simple lathe to lathes with traversing mandrels, and screw-cutting lathes, with the usual back gear and slide-rest. The next portion of the book deals with apparatus added to the lathe for specific purposes, such as the division plate, the slide-rest, spiral apparatus, &c. Then come the various sorts of chucks. After this we have a chapter of practical instruction on soft-wood turning; then similar chapters dealing with hard wood and ivory, and with elementary metal turning; screw-cutting is the next subject treated, and the chapter which succeeds this is devoted to the sphere and various forms of hard wood and ivory derived from the solid. Then come some practical examples of simple plain turning in wood and ivory, and similar examples of combined plain turning. A miscellaneous chapter, dealing with various points which could not be brought in under the classification adopted in the book, concludes the work.

LOCAL GOVERNMENT AND TAXATION IN THE UNITED KINGDOM; a Series of Essays published under the sanction of the Cobden Club. Edited by J. W. Probyn. London: Cassell, Petter, and Co., 1882. 8vo.

This forms a companion volume to the series of essays on the same subject published by the Cobden Club in 1875. The following subjects are contained in the present series:—Local Government in England, by the Hon. George C. Brodrick; County Boards, by C. T. D. Acland; the Areas of Rural Government, by Lord Edmund Fitzmaurice; London Government, by J. F. B. Firth; Municipal Boroughs and Urban Districts, by J. B. Bunce; Local Government and Taxation in Ireland, by R. O'Shaughnessy; in Scotland, by Wm. Macdonald; and in England and Wales, by J. R. Phillips.

ASHE PYEE, THE SUPERIOR COUNTRY; or the Great Attractions of Burma to British Enterprise and Commerce. By Colonel W. F. B. Laurie. London: W. H. Allen and Co., 1882. 8vo.

In a former work, Colonel Laurie dealt with the history of our wars in Burma, but in the present one he shows what openings there are in that country for more peaceful undertakings. The title, Ashé Pyee, which the author has taken, means, literally, "the Eastern Country," but is also understood by the Burmese to mean the first or superior country. The Burmese are supposed, by themselves, to belong to the Solar race, and the sun rising in the east, and shining from the first on their country, they believe it to be the first country in the world. Colonel Laurie devotes a chapter to the consideration of Sir Arthur Phayre's paper on British Burma, read before the Indian Section of the Society of Arts, on May 13, 1881, and expresses the opinion that this was the first really great public effort to draw attention to Burma. In noticing the resources of the country, the author draws special attention to the bamboo, and Mr. Routledge's proposal to obtain paper from that tree.

TRADE MARKS; Notes on the British, Foreign, and Colonial Laws relating thereto. By Geo. Gatton Melhuish Hardingham. London: Stevens & Sons, 1881. 8vo.

The Trade Marks Registration Aet of 1875, the Amendment Act of 1876, the Extension Act of 1877, and the Rules under these Acts are printed in this volume, which also contains an account of the action taken by most of the countries of the world in regard to the protection of trade marks. From this it appears that regulations respecting trade marks have been in force in Russia since 1830. Proprietary rights in trade marks are protected in Spain by a Royal decree of 20th Nov., 1850, and in 1857 a law was passed in France with the same object. Austro-Hungary followed with a law in 1859; Italy, in 1868; Turkey, in 1870; Germany, in 1875, and Brazil in the same year, which was also the date of the English Act. Since our Acts, Belgium and Roumania, in 1879; Denmark and Switzerland in 1880, and the United States and Holland in 1881, have passed laws for the protection of the owners of trade marks. It appears that no special laws relative to trade marks have been passed in Greece, Norway, Portugal, and Sweden.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

MARCH 29.—"A New Antiseptic Compound and its Application to the Preservation of Food." By Prof. BARFF, M.A. Dr. W. J. RUSSELL, F.R.S., will preside.

Meetings after Easter :—

Discussion on "the Channel Tunnel." To be opened by Sir EDWARD WATKIN, Bart., M.P.

"The Constant Supply and Waste of Water." By GEORGE F. DEACON. Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, will preside.

"Telephonic Communication." By LIEUT.-COL. C. F. WEBBER.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock :—

APRIL 25.—"The Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. NOEL SHORE, author of "The Flight of the Lapwing." Sir RUTHERFORD ALCOCK, K.C.B., will preside.

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock :—

APRIL 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS and PERCY C. GILCHRIST.

MAY 11.—"The Recovery of Sulphur from Alkali Waste by Schaffner's process, a record of recent results." By ALEXANDER M. CHANCE, of Birmingham.

INDIAN SECTION.

Friday Evenings, at Eight o'clock :—

APRIL 21.—"The Mineral Resources of India, and their Development." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India.

MAY 5.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Third Course is on "Hydraulic Machinery," by Prof. JOHN PERRY.

LECTURE IV.—MARCH 27.

Lifts. The new balance method, as applied in bridges, canal boat, and other lifts. The transmission of power to machines at a distance by means of water. Applications to various tools. Comparison of hydraulic and electrical methods, and the part which each is likely to play in the future.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. John Perry, "Hydraulic Machinery." (Lecture IV.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Edmond O'Donovan, "Merv and its Surroundings."

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. A. F. Burridge, "The Rates of Mortality in Victoria, and the Construction of Mortality Tables from Census Returns by the Graphical Method of Valuation."

Medical, 11, Chandos-street, W., 8½ p.m.

Surveyors' Institution, 12, Great George-street, 8 p.m. Mr. R. R. Rowe, "Glebe Terriers."

TUESDAY, MARCH 28...Royal Institution, Albemarle-street, W., 8 p.m. Prof. J. G. McKendrick, "The Mechanism of the Senses." (Lecture XI.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 52, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. Charles B. Bender's paper, "The Design of Structures to Resist Wind Pressure;" and on M. Jules Gaudard's paper, "The Resistance of Viaducts to Sudden Gusts of Wind."

WEDNESDAY, MARCH 29....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Barff, "A New Antiseptic Compound and its Application to the Preservation of Food."

Institute of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 o'clock. Annual Meeting. The Address by the President. Reading of Papers and Discussion.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. J. Burdon Sanderson, "Pathology of Inflammation." (Lecture II.)

Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Exhibition of Spring Flowers.

THURSDAY, MARCH 30TH....Institute of Naval Architects, (at the HOUSE OF THE SOCIETY OF ARTS). Morning meeting, 12 o'clock. Reading of papers and discussion. Evening meeting, 7 p.m. Reading of papers and discussion continued.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. Annual meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Resemblance of Sound, Light, and Heat." (Lecture II.)

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. B. Staughton, "Statistics of Railway Travelling and Tonnage in 1880."

FRIDAY, MARCH 31ST....Institute of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS). Morning meeting, 12 o'clock. Reading of papers and discussion. Evening meeting, 7 p.m. Reading of papers and discussion continued.

Royal United Service Institute, Whitehall-yard, 3 p.m. Captain P. H. Colomb, "On the Manœuvering of Steam and other Ships."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. W. Spottiswoode, "The Electric Discharge in a Magnetic Field."

Royal College of Physicians, Pall Mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. J. Burdon Sanderson, "Pathology of Inflammation." (Lecture III.)

Quekett Microscopical Club, University College, 8 p.m. Special exhibition meeting.

SATURDAY, APRIL 1...Royal Institution, Albemarle-street, W., 3 p.m. Professor H. G. Lesley, "Volcanoes." (Lecture III.)

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FRIDAY, MARCH 31, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

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CANTOR LECTURES.

The fourth and concluding lecture of the course on "Hydraulic Machinery" was delivered by Professor John Perry, on Monday, 27th inst. The lecturer began with a description of lifts, and of the new balance method as applied to bridges, canal boat, and other lifts. He then dealt with the question of the transmission of power to machines, and its application to various tools, concluding with a comparison of hydraulic and electrical methods, and the part which each is likely to play in the future. The lecture was illustrated by models and a large number of diagrams, kindly lent for the occasion.

The Chairman (Mr. B. F. Cobb) proposed a vote of thanks (which was carried unanimously) to Professor Perry, for the interesting course of lectures then completed. He was sure that all had listened with the greatest interest to the clear and animated descriptions which the lecturer had given them.

The lectures will be printed in the *Journal* during the summer recess.

ANIMAL LOCOMOTION.

On Tuesday next, April 4, at eight p.m., Mr. Muybridge will explain the results of his researches on "Animal Locomotion," and will exhibit, by means of the electric light, the photographs he has taken of animals in rapid motion. The actual motions of the animals will be reproduced on the screen by the help of Mr. Muybridge's new instrument, the "Zoepracticoscope." Admission will be limited to Members only.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

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SEVENTEENTH ORDINARY MEETING.

Wednesday, March 29th, 1882; Dr. W. J. Russell, F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Heathman, J. H., 63, Long-acre, W.C.
Jackson, John Archer, Sunnyside, Hawkhurst, Kent.
Jeffreys, Edward Alexander, M.I.C.E., Gipton-lodge, Leeds.
Jenkin, Fleeming, F.R.S., 3, Great Stuart-street, Edinburgh.
Moore, Benjamin Theophilus, M.A., M.I.C.E., Cavendish-house, Teddington.
Tangye, James, Aviary-cottage, near Redruth, Cornwall.

The following Candidates were balloted for and duly elected Members of the Society:—

Barclay, Arthur, M.I.M.E., 12, York-street, Covent-garden, W.C.
Brown, George William, M.I.M.E., Reading Iron Works, Limited, Reading.
Calthorpe, Lieut.-General the Hon. Somerset G., Woodlands, Ryde, Isle of Wight.
Fenwick, Clennell, Victoria Docks Engine Works, Victoria-docks, E.

Harfield, William Horatio, Mansion-house-buildings, E.C.
Harris, William Wallington, 24, Alexandra-villas, Hornsey-park, N.
Harwood, Robert, Vale Bank, Bolton, Lancashire.
Macay, Juan Francisco N., 79, Coleman-street, E.C.
Mills, Miss Emily, Queen's College, 70, Upper Tollington-park, N.
Sellon, John Scudamore, 79, Hatton-garden, E.C., and Sydenham-hill, S.E.
Tracy, Hon. Hubert Hanbury, Brooks's Club, S.W.
Winser, John Johnson, Laetaville, 7, Cloudesley-street, Barnsbury, N., and Lincoln's-inn-chambers, 40, Chancery-lane, W.C.

The paper read was—

A NEW ANTISEPTIC COMPOUND, AND ITS APPLICATION TO THE PRESERVATION OF FOOD.

By Professor F. Barff, M.A.

Five or six years ago, while experimenting on methods for the preservation of food, I adopted a process which depended on the absorption of oxygen by some suitable substance; the food to be preserved being enclosed in hermetically sealed vessels. The substance I employed for this purpose was green vitriol, or protosulphate of iron; this was mixed with lime, or soda-lime, which rapidly decomposed it, setting free the protoxide of iron, and this absorbed all the oxygen in the vessel. Owing to the formation of sulphate of lime, which, when moist, sets in hard masses, the action was not always complete, as some of the protoxide of iron got locked up, and was so removed from the air; to prevent this, I rubbed up with the mixture some cork or oak sawdust to keep the mass porous, this assisted in the absorption of the oxygen, as either of these substances with lime, or better, soda-lime, itself absorbs oxygen; in fact, oak sawdust and soda alone, when moist, will absorb all the oxygen in any vessel containing air. Many experiments were made which proved conclusively that the whole of the oxygen of the air could be absorbed; and several specimens of raw beef were for a long time successfully preserved, but on most occasions, when the vessels were opened, the meat, though looking perfectly fresh, had a very unpleasant smell, which rendered it quite unfit for food. After long investigation, the causes of this were discovered; some of the juices of the meat came in contact with the lime or soda employed, and ammonias were formed, which gave rise to these unpleasant odours. The difficulty in overcoming this defect was so great, that I at last abandoned the investigation, and turned my thoughts in other directions. It is well known that boracic acid is an antiseptic, but its very slight solubility in water renders it, by itself, useless as a preservative of meat. About this time a process was submitted to me, in which tartaric acid was used as a solvent for the boracic acid for the purposes of food preservation. I examined and reported favourably on the process. Specimens of meat treated by it were well preserved. For certain purposes of food preservation it had defects, although beasts injected with it were kept in very good preservation; yet, if the meat was soaked in the fluid, the meat was preserved, but in a very short time the fluid decomposed and stank. It was clear, therefore, that this material could not be used where its presence was required in the wet state, in the substances to be be preserved, as in milk or cream. My idea was, then, to get something which would preserve the meat, or other food, and would itself not decompose; for, as I shall try to show before I conclude this paper, that however desirable it is to bring from meat-producing countries whole animals, yet there are other and cheaper methods of easing the meat market, in this and other countries, which should not be neglected. My object in this paper is not to say anything against any existing successful methods for bringing meat from abroad, nor do I wish in the least to interfere with them. The frozen meat process has given good results; it is founded in reason, and I wish it all success. But the quantity of food which we require, and the cheapness with which it can be obtained, are subjects which I am sure you will agree with me demand the attention of all scientific persons. I tried a number of experiments on solvents for boracic acid, but the result of my work was to show me that no mere solvent was the thing wanted; that some substance should be used which formed a definite chemical compound; for, if a definite compound could be found, then the substances used must always be in the same proportion, if properly compounded. Biborate of soda, or borax, is a solvent for boracic acid, but in using it a large quantity of soda is used which has no preservative action in itself; and could be dispensed with, except that it assists in acting as a solvent for boracic acid. Not to trouble you with the results of my abortive experiments, I will mention that glycerine came to my mind as a very likely substance for my purpose. It has great solvent powers, and then, it is a substance in which some of its hydrogen can be replaced by other bodies. The well known explosive nitro-glycerine is glycerine in which some of its hydrogen has been replaced by NO_2 the radical of the nitrates. I found that glycerine, when heated, readily dissolved boracic acid, and I tried many experiments with it in the earlier stages of my work, but always there was a sweet taste, which was objectionable for any preservative substance. To be successful it must be free from any taste. Another reason for the use of glycerine was its well-known property of arresting the growth of germs. Many experiments have been tried with it, an account of which may be seen in the last supplement of Watts's "Chemical Dictionary" on the subject of ferments. It was at first tried to get substitution products with boracic acid, similar to those obtained with nitric acid, and my friend, Mr. Paul, who has worked with me all through these investigations, is at present engaged on the subject, and with every prospect of success, so that I hope, before long, we shall be able to publish some interesting and satisfactory results. I have lately seen it asserted that boracic acid alone has not the power of preventing decomposition, but only in combination with other substances, and my own experience entirely confirms this statement. I will now proceed briefly to state the result of our experiments in the preparation of this compound for the preservation of food. Fats are composed of two bodies, an organic acid, or organic acids, chemically united with a substance called glyceril, the symbol for which is $C_3\,H_5$.

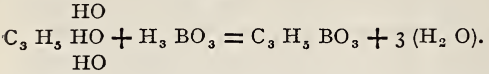
This glyceril acts as a base with which the acid is combined, therefore, fats are salts, just as carbonate of soda is a salt; and one part of the salt, viz., the base, can be replaced by another base, and therefore a new salt can be formed. This is what takes place in the manufacture of soap. Soap is a salt in which the organic base of a fat has been replaced by a mineral base, such as soda. If some oil be boiled for a time with litharge, protoxide of lead, and water, the fat is quite decomposed; its organic acid unites with the oxide of lead, forming a lead salt with the organic acid, and the glyceril which is expelled takes up the elements of water, and becomes glycerine.

Thus: $C_3\,H_5 + \begin{matrix}HO\\HO\\HO\end{matrix}$ becomes $C_3\,H_8\,O_3$ glycerine,

and this glycerine can be collected and purified. This is one way in which it can be obtained, but when the fatty acids are wanted for special purposes, such as candle-making, and it is not wanted to have them in combination with other bases, glycerine is obtained by acting upon fats with superheated steam, and in this way it is set free, the fatty acids being left alone, the glycerine taking up the elements of water from the steam employed.

The substance which we obtain by the action of boracic acid, or glycerine, is a body analogous in its composition to fats; it consists of glyceril united with boracic acid instead of with a fatty acid. If 92 grammes of glycerine be mixed with 62 grammes of boracic acid, and if the two be heated together, an action takes place, and steam is given off. In conducting this experiment, it is best to heat the glycerine to a tolerably high temperature, and add the boracic acid in small quantities, continually stirring. The boracic acid dissolves rapidly at first, but towards the end of the operation, it takes a much longer time to dissolve. If the mixture be allowed to cool directly the boracic acid is all melted, a crystalline precipitate will be found to separate out. This precipitate is probably boracic acid, which has only been for the time held in solution, and has not gone into chemical combustion with the glyceril. If the mixture be now weighed, it will be found to have lost weight, for it will weigh 131 grammes, whereas at first, when it was mixed, it weighed 154 grammes. If tasted now, it will have a sweet taste of glycerine. After this mixture had been heated a second time, a crystalline precipitate again separated out on cooling, and during the whole heating process, steam was freely given off. When cold, its weight was found to be 116 grammes. Different experiments as to its solubility in water were tried, and as the chemical combination became more perfect, its solubilily in water increased. After a third heating, on cooling, no crystalline precipitate separated out, but the mass, when cold, set into a hard mass, like ice; it was somewhat brittle, as ice is, and its surface, when struck with an instrument such as the screw-driver, broke as ice breaks; that is, it was readily chipped, and the small pieces were found to be hard and dry. The weight of the mass was now found to be 100 grammes. 154 grammes had therefore lost 54 grammes, and this exactly corresponds to the weight of three molecules of water, for one molecular H_2O weighs 18. Here is represented, symbolically, what took place:—

Glycerine. Boric Hydrate.



$$C_3 H_5 \begin{matrix} HO \\ HO \\ HO \end{matrix} + H_3 BO_3 = C_3 H_5 BO_3 + 3 (H_2 O).$$

Mr. Paul has often and carefully analysed this ice-like glacial substance, and has found that it quite answers to this formula. It may be well to explain for those who are not well practised in chemical formula, this equation in words. C_3 H_5 glyceril chemically united with 3 (HO) forms C_3 H_6 O_3 glycerine; H_3 BO_3 is the molecule of hydricborate; B_2 O_5 is the molecule of boracic acid. Under the action of heat, the H_3 from the boracic acid unites with the 3 (HO) of the glycerine, forming 3 (H_2O) three molecules of water, and the BO_3 of boracic acid takes their place, forming C_3 H BO_3. For my purpose to-night, I think I have gone quite fully enough into the scientific part of the question. I have already mentioned that my friend Mr. Paul is working with me at the subject, and he will prepare a paper which will, I believe, be full of scientific interest.

The demand for food in this and in other densely populated countries is so great, that all methods for importing in a wholesome condition, foods from food-producing countries, must demand attentive consideration. When I first mentioned this matter to persons who knew the meat trade, the first remark made was, does it alter the external appearance of the meat? I do not think that this is a matter of vital importance, and for this reason, salting meat alters its appearance, and yet people eat salt meat freely. Salt meat is not imported from distant countries, where it has to travel in hot climates, because so much salt is required to preserve the meat, that it interferes with its flavour and nutritive properties; but suppose that meat mildly salted, such as is usually eaten in London, could be brought from Australia or South America, would its appearance interfere, therefore, with its sale? and suppose a very large quantity of the salted meat consumed in London and other large cities in England and on the Continent, could be obtained at 4d. or 5d. a pound, would it not be a great boon to the people, and also would it not greatly ease the meat market, and tend to reduce the price of fresh meat at home? I make these remarks to prove that there are ways by which we can increase our food-supply without bringing our meat to be exhibited in rivalry as to appearance and price with home-grown, fed, and killed meat. Do not understand me to mean that the process which I am describing will not bring meat to the English and other markets in a saleable condition and perfectly fresh, having its true flavour; but what I want to-night to show as well is, that other methods can be employed in which a greater general saving can be effected than by the exclusive attention to producing foreign meats in quarters, &c., so as to be placed side by side on the markets with our own meat. I will just take the liberty of laying before you, methods in which foods of different kinds may be imported adapted to particular requirements, and then I will conclude with some remarks as to the importation of beasts, whole or in joints. This evening I have on the table specimens of food which have been kept for longer or shorter periods as they are intended to illustrate various applications of this preserving material. As you know, oysters are imported very largely in tins. They are cooked at a high temperature and hermetically sealed. The high temperature to which they are exposed, necessarily causes a loss of flavour, and it is generally remarked that tinned oysters are not a success. This remark, however, requires some qualification, for the oysters tinned and supplied by some of the English firms are really very good, though not to be in any way compared to those freshly opened. I have eaten oysters tinned by Messrs. Crosse and Blackwell, when used for sauce or patties, so good that one had to think twice whether they were not fresh oysters. I have oysters on the table which which were opened on the 3rd of December in last year. I will ask you to taste them, and see in what condition they are, and I would also remind you that they have not been kept in hermetically sealed tins, but simply in corked or stoppered bottles; hence this method of preserving oysters is cheaper than the other, and I maintain that it is more effective, because their natural and fresh flavour is preserved. I am informed by a friend in Jamaica that he has sent me some Jamaica oysters and other things: I trust they will be here in time for me to submit them to you this evening. Another substance, the perfect preservation of which is very important, is cream, both for home use and for exportation. Cream in London costs from four shillings to five shillings a quart; it can be bought in country places for two shillings, and even for less. This preservative substance will keep cream for months perfectly good and sweet, having its full flavour;

so that it would be quite possible to send it in quantities from the country, and its sale need not be pressed as it need not be used immediately. I have regularly every week, except during the holidays, brought with me from Beaumont College, near Windsor, where I lecture, a quart of cream treated with one ounce of the boroglyceride; it has always kept perfectly good even in the hottest weather. I have done this for a year and a half; a near relative has taken the greater part of this regularly for the time stated, and this proves conclusively that there is nothing at all injurious to health in the compound. I see a gentleman here present to-night who is connected with that college as a professor of natural science, and he will, in the discussion, be able to give you very valuable information as to the material, and as to its perfect wholesomeness. Last month I sent some cream to the Rev. J. Ryan, a Jesuit priest, in Jamaica, and I have received a letter from him, from which I will read you an extract:—

"26, North-street, Kingston, Jamaica,
"February 24th, 1882.

"The cream which you sent was used by eight of us in coffee, and was pronounced to be wonderfully good. Next morning it was taken in preference to a beaten egg, by the captain of H.M.S. *Tenedos*, to his coffee."

Last year I sent some Devonshire clotted cream, which I prepared myself, to Zanzibar, on the east coast of Africa; the climate here is very hot, fresh food will only keep a few hours. This cream had to pass through the hot climate of the Red Sea. I will read an extract from a letter written by a lady who received the cream:—

"Universities' Mission to Central Africa,
"Mbweni, Zanzibar, March 8th, 1881.

"The Devonshire cream you sent us was quite a success. I received it last night. Fortunately the Bishop and Miss A——— came to Mbweni to day, so we had it for dinner; that I might have everything correct, I opened a pot of raspberry jam which we had from London a long time ago. The Bishop said it had kept perfectly, but had not quite the rich flavour that it has when quite fresh; he has been used to it in Devonshire; everyone pronounced it most excellent. We sent some in to Mrs. H——— and were surprised at her sending for more, for she seldom eats half anything we send her; she did not know what it was, but she said she had never had anything here she enjoyed so much."

A year ago I sent some cream from Beaumont College dairy to the Rev. Thomas Porter, the head of the Jesuit Mission in the West Indies. He states that the cream was as good as any he had eaten at home, that he gave it to several strangers to eat, and that they would not believe that it came from England. These experiments and these testimonies prove conclusively that this compound will preserve cream. I shall this evening show you specimens; it is easy to send cream in good condition to the Tropics. A great objection to condensed milk is that it is always too sweet. The boroglyceride will preserve condensed milk, and will give it no flavour at all. My friend, the Rev. Thomas Porter, sent me some articles preserved with the material, which I sent him from England; they arrived about June in last year. Some raw, fresh turtle, came quite fresh; it was cooked and eaten by several persons, who said it was quite fresh and good, and had the flavour of fresh turtle. At my own house I had turtle cutlets fried, they were perfectly good, and tasted like turtle. Another article which Father Porter sent me was an uncooked Jamaica pigeon; it was roasted at Beaumont College. I divided it and brought half of it home; it was tasted by twelve people, who all pronounced that it was perfectly good, and had the true pigeon flavour. In the same parcel came some green sugar-cane, fresh tamarinds, taken direct from the tree, fresh limes, and the juices of two different fruits—all were fresh, and were tasted by gentlemen who had lived in Jamaica, who all declared that they had all their own peculiar flavours. On the 3rd of September, 1881, another box was sent me from Jamaica, containing sugar-cane, guavas, fresh ginger, and turtle; the turtle had come to grief, becaase it was not properly treated on the other side; the cane, guavas, and fresh ginger, have been tasted by those who have lived in Jamaica, and have been pronounced to have their true flavours.

Ordinary milk cannot be kept good for a long time, especially in hot weather. If milk were concentrated in this country, and heated with the boroglyceride, carriage would be saved, and the milk might be kept good and fresh for a fortnight, and more; all it would require would be to reduce it again to its original strength. If fresh milk be treated with this preservative it can be set for cream for several days, even in hot weather. The cream which rises will keep, and the skim milk will remain sweet for several weeks; this I have tried in the dairy at Beaumont College. From the cream so prepared butter was made, and was kept for several weeks without a particle of salt, and was eaten by members of the College. I also wish to show another method by which meat can be preserved and cheaply transported. In South America, about Buenos Ayres and the River Plate, many cattle are killed simply for the hides and fat, the flesh is thrown away; now, if this flesh were cut up in small pieces, and put into the preserving liquid for a night, it would, even in that hot climate, keep good for some time. It could then in a few hours be dried in the sun, packed in casks, and sent to this or to other countries. I have a specimen of beef treated in this way. It was put into the solution on January 19th, 1882, dried February 1st, and has lately, within a few days, been boiled, and here is the resulting beef tea, which has not in any way been flavoured. I have also small quantities of beef juice here preserved in bottles. The juice was expressed, and has been kept raw. Raw beef and mutton juice is recommended by medical men in many conditions of the digestive system. I administered it to a near relation for six weeks, and the juice was preserved good by my material; in the case referred to the effect was very satisfactory. It appears to me to be a most important matter that soup meat, and meat for potting and stewing, should be sent to this country in the way I propose. The supply would be large, the prices low, and the profits highly satisfactory, and it would greatly relieve the meat market, because a very large quantity of fresh meat, which is now used for soup, could be employed in other ways. It has been remarked to me, "But would you get people to use it?" I think, to begin with, that if proprietors of hotels and heads of large public institutions, workhouses, and hospitals, could be shown that for half the cost they could have equally good soup and soup stock, that they would willingly use it, and from thence it would come into private use. I have specimens to show the effect of boroglyceride on fish. Here are sprats which have been kept for a year; they are dry, but perfectly good and eatable; also some preserved fresh since January 13th, 1882. You will be able to judge of their appearance and flavour. I have also herrings and a piece of skate, which have been preserved for the same time. If fishmongers had a tank of this solution, they could, at the end of the day, put their fish in it, and take it out when required. Bloaters, when lightly cured in hot weather, do not keep good many days; if a small quantity of this stuff was used with the salt, they would keep good for months. The same may be said of smoked salmon. That which is very salt costs 9d. per lb., but the mild cured kinds cost 3s. 6d to 4s. per lb. All could be mildly cured if this material was used with the other curing substances. As an adjunct in curing mild hams and bacon, it would be of great use, for these, when cured lightly, would not go bad, as they often do in the summer time. What I have said as to the temporary preservation of fish by fishmongers applies equally to the preservation of meat and fowls by butchers and poulterers.

It is justly complained of, that the Australian cooked meat is over-cooked. If it were for a short time dropped in this preservative solution, it would keep perfectly well after being lightly cooked, even under-done. I have a piece of beef which was dipped on the 28th February, and boiled on March 9th; it has been left in its own liquid, it was not flavoured, and no salt was added. Here, too, is a vast field for the application of the process. Here is also lobster, which was taken out of the shell February 1st, and here are two lobsters in their shell, which were immersed on the same day.

I now wish to draw your attention to a parcel from Jamaica, which has just arrived, and from which I am able, I am happy to say, to show you specimens which must be of interest. In a jar on the table is some fresh turtle, which I had simply cooked. I thought it better so to present it to you rather than raw. There is also a Jamaica pigeon, also just cooked here, and a *vol au vent*, which I have had made from oysters, which were sent open in the preserving stuff from Jamaica. These specimens will prove conclusively that food sent from a tropical climate retains its freshness and delicate flavour. I have reserved one of the pigeons raw, that you may see in what state it arrived. Some mutton was shipped to me from the Falkland Islands, at the beginning of last August; a piece of it is uncooked on the table. I have also had a piece stewed, which you will be able to taste; this has, of course, passed the Tropics. Through the kindness of my friend, Mr. Haffenden, of the "Andaluzia," in the Strand, who owns vineyards in the South West of Spain, I can show you some perfectly-fresh sardines, which he had placed in the preserving fluid several months ago in Spain, and which he brought with him; you will yourselves judge of their condition, I will only remark that they have the peculiar fragrance of that delicate fish, and will it not be a boon to have a supply of this fresh delicacy at a moderate cost? You will also see, and I hope taste, a pigeon pie, the pigeons and the steak have been preserved raw in stoppered bottles since the 21st of last November, and the eggs since the 4th of July, 1881. I will also call your attention to a tongue, which I myself placed in the solution, February 9th, in this year, with some garlic, sugar, and juniper berries, my object being to show that salt can, if desired, be dispensed with. You will, doubtless, find that it will require salt; but you will readily infer that hams, tongues, &c., can be made just as salt as one pleases, and will yet keep perfectly sweet, in fact sounder, than those cured only with salt. This tongue was boiled out of pickle. I exhibit two shoulders of mutton, one cooked, the other raw; they are from sheep killed January 10th, 1882. Also a piece of beef preserved on the same day; this, when you have inspected it, shall be cut in slices and broiled. You will see some sausages, both cooked and uncooked; they were made for me by Mr. Bowron, poulterer, of Paddington, early in July last, before I went to Carlsbad. I took some with me to that place, and they were there eaten and pronounced good. These are some of the same lot, they were made as follows:—The meat was chopped, put into the preserving fluid for one night, and then mixed with the other material in the ordinary way. They have been kept since in an earthenware jar; they have, therefore, been made more than nine months. I may remark that the bread in these sausages was not treated, and, therefore, it has become slightly sour, but the pork has kept perfectly fresh. I have also some other sausages, which I bought January 12th, and at once preserved; these having been steeped, the bread has not turned in the slightest degree sour.

Mock turtle soup bought ready made from a confectioner's shop in Oxford-street, January 25th, treated with the preservative stuff, has remained quite good, and unchanged in flavour.

There is also a specimen of gravy soup made in October last, and some vermicelli soup made about three weeks ago. The preservative action of the boroglyceride in cooked foods is, it seems to me, of great importance to hotel keepers, confectioners, and restaurant proprietors, as it will enable them to buy large stocks when certain articles are cheap, and from the specimen I show of cooked beef, you see it remains quite moist, as it can be kept, without getting sour, in its own gravy and under a layer of its own solid fat. To prove that articles can be kept and dried without losing their flavour, I had some partridges treated and dried last February twelvemonth, and I exhibit some soup made from two of these birds. The other articles on the table are, one raw and one roast foul, bought January 17th; one raw and one roast pheasant, bought February 5th; one rabbit boiled, bought January 17th. There are also from Jamaica, a green lime, some fresh tamarinds, and some pieces of fresh ginger.

You will notice on the table frying-pans, &c., and some of you will, doubtless, remember the time when I had the honour in this room of introducing to your notice a process for the prevention of rust on iron. I had intended using them this evening, and for the nonce turning cook before you, but Mr. Wood kindly suggested that the housekeeper should do the cooking below, so as to save you from the unpleasant smell of mixed odours. These cooking utensils have been all treated by what is now called the Bower-Barff process, and as you will pardon a little vanity in me, I feel sure I may sing the praises of my child, now that in abler hands than mine, he has been reared and rendered fit for introduction to the public. I have used such cooking vessels ever since I read my paper; they are better and far cheaper than those made of copper. White sugar can be boiled in them for preserving crystalised fruits without the slightest discolouration.

But before concluding, I wish to state that I have made experiments on the effect of the boroglyceride on fermentation, but they are not yet brought to a complete issue. When added to a fermentative mixture, it prevents fermentation, when added after fermentation has begun, it does not stop it, it only moderates it. A gentleman, Mr. McNisch, of St. Neot's, Hunts, largely engaged in the export beer trade, tells me it so far does not interfere with the condition of bottled beer; he requires a longer time to test its preservative powers. A year ago, my friend the Rev. Mr. Dobson tried experiments with beer; he will tell you the results of them. As to cost, I can assert that it will not materially affect the price of the articles preserved. I thank you, ladies and gentlemen, for the patient hearing you have given me.

DISCUSSION.

The CHAIRMAN said the paper was marked by the clear and philosophic way in which the subject was treated, and before inviting discussion upon it, he would mention shortly his own experience of the process, the only interest of which was that it was quite independent of Professor Barff. When he was asked to take the chair, he communicated with Mr. Barff, and inquired what the process was; Mr. Barff kindly sent him a specimen of this substance, which he melted, and put some of it into one half of a pint of cream. The other half very soon turned sour, and had to be thrown away, but that to which the substance was added was perfectly fresh that morning. He was confirmed in the opinion of its freshness by the cook, though she said there was a very slight tartness perceptible, by which she could distinguish it from fresh cream. He had also tried another experiment on meat which was chopped very fine, and divided into two parts; to one part he added merely tepid water, to the other, tepid water to which $\frac{1}{16}$ of its bulk of this compound had been added. This was left on the meat for 18 hours, and then filtered off through muslin. Several days ago the portion which had no preservative was very offensive, but the other portion was that morning perfectly free from any odour whatever.

Dr. C. **Graham** said the subject of fermentation was one which interested him very much. All decomposition and putrefaction of animal and vegetable substances was entirely due to the agency of minute organisms; and mankind, long before Pasteur had given to the world the results of his researches on ferments, found out various ways to prevent the action of these bacteria. Thus the process of drying, as applied in Charki beef, was tried, but he did not consider it very successful. Again, chemicals of various kinds had been used, and in particular common salt, but that extracted some of the valuable constituents of the meat, and therefore that method could not be called entirely successful, though it had its uses. So, again, with the smoking of fish, it preserved it, but altered its flavour. One of the most recent applications of science to such a purpose, viz.: the use of salicylic acid as a preservative of beer and other fermenting liquids, had been recently condemned by the French Government as unwholesome; and he should like to know if any experiments had been made with this compound on liquids, such as beer and vinegar. In England, beer was highly hopped to preserve it; but the narcotic principles of the hop rendered the beer less suitable as a beverage than it would be otherwise. Beer was not intoxicating, on account of the small quantity of alcohol in it, so much as from the narcotic principle in the hop, and the Germans had therefore adopted the use of ice as a preservative instead. If this process turned out only half as successful as Mr. Barff had said, it would be of great value economically. In his view, flavour depended in a great degree on the aroma of certain volatile substances, of which little was known, and he should like to know how far these were affected by this process.

The Rev. J. L. **Dobson** said he had had the pleasure of being associated with Mr. Barff in most of the experiments he had detailed, and might therefore anticipate his reply to one or two points raised by Dr. Graham. An experiment which was tried for some time in a large school would answer the question of wholesomeness. At the Beaumont College, Windsor, there was a large staff of teachers, and over 200 pupils, and during the hot weather of last summer the dairymaid was very much annoyed at the milk turning sour, and applied to him to see if he could do anything to counteract it. He handed her some 14 or 15 lbs of this material, and during the whole of the hot weather, and well on into September, it was constantly used, and the milk was preserved; but the method was not detected by anyone, either by the younger members, or by those who might be expected to be more critical. No ill effects were observed by the medical officer, or by individuals. From his own experience, he thought the aroma was very well preserved throughout. For instance, in oysters which had been preserved over three months, there was the characteristic aroma of the fresh oyster; mutton could be easily distinguished from beef, and the peculiar smell of the turtle was also very distinct. They had not yet tried beer with so much fulness as other articles, but, about nine months ago, a small quantity was treated, and left exposed to the air, with only a loose stopper of cotton wool. It did not grow cloudy in the ordinary way, but owing to the severity of the experiment, and perhaps to not sufficiently treating it, after four months it lost all flavour, became extremely flat, and a slight fungus appeared.

Dr. **Thudichum** had listened with great pleasure to the paper, and had no doubt if the application of the invention could be effected on a large scale, it would be very useful. He had some experience with regard to a portion of the ingredients used, viz., boracic acid, though he had none of this beautiful new compound. It might not be known to the meeting that boracic acid had been used for a great many years for preserving food, and in fact many of them in summer time had their milk well dosed with it. It had been sold to milkmen in London for years under the name of "aseptin." He had tested it in 1865, and found a great many of those effects which Mr. Barff described. For instance, eggs were beautifully preserved, and steak immersed in the solution, did not become either mouldy or rotten, but on the contrary appeared to retain its flavour. A variety of other things, such as cheese and cream, were, either for a long time or for ever, preserved by this application of aseptin. He hoped the addition of the glycerine would increase the power, and prevent some drawbacks which would otherwise stand in the way of boracic acid alone as a preservative of raw or cooked meat. He should, however, like to know a little more about its effects on the human body, and particularly whether it passed through the body unchanged. Boracic acid itself had not as yet been proved to have any deleterious effect on the animal economy. It went into the body and passed out again unchanged. Some observations which had been made ought to be reconsidered on many grounds. For instance, the objection to salt meat. Very few people understood the philosophy of salt meats; the idea that meat by salting lost any considerable portion of its nutritive value was entirely erroneous. No doubt some albumen was extracted from the outer portion of the meat in salting which went into the brine and was lost, but it was very slight, as the researches of Professor Voit, at Munich, had shown. The advantage of salt meat was of a different kind; it had a dietetic value of its own. The human body had to work up a great quantity of potash salts; in the case of an Irish labourer, who had to eat 8 lbs. of potatoes a day to keep himself alive and strong, the quantity was 40 grammes; and the labour which was thrown upon the emunctories to get rid of that was very great, particularly if it had to be got rid of in the shape of phosphates. The only set-off against it was that, by consuming a large quantity of salt, a double decomposition of the two salts took place, and thus the potash salts were more easily eliminated; if it were not so, the man would soon be ill, and unable to digest his food. Therefore, the labouring classes who had to eat a great deal of vegetable food, partly potatoes, were benefited as regards diet by having to eat salt meat. If it was found that the practice of mankind almost all over the world could be proved to be scientifically correct, they ought to be rather careful how they interfered with it, before they knew the full effects of what they were doing. As regards other preservatives, he thought the greatest of all with regard to meat was cold. He hoped, however, that this interesting discovery would be highly successful, for there was no doubt we wanted cheap meat and fish, in order to improve the diet of the working classes.

Mr. A. S. HASLAM had listened to the paper with great pleasure, but would have felt more satisfied if fuller details had been given of the course of the process. For instance, he should like to know what would be the cost per lb. to preserve meat by this process. After all, it was a commercial question, whether it could compete with other known processes which were already in successful operation. He should also like to know whether it could be applied to a whole carcase, or what was the largest joint which could be treated. Unless you could bring meat in the shape of a joint before the public, the price would be very much reduced.

Mr. WENTWORTH SCOTT said he had taken some interest in this question, and, on a former occasion, had exhibited various specimens in that room. The various modes by which meat could be cured, might be divided into the mechanical class, which simply, by some envelope or barrier, shut out the ingress of germs calculated to destroy an organic substance; and the chemical class, by which they were destroyed, or their action neutralised or suspended. The title of the paper had been taken exception to by some people, inasmuch as both the substances which, in the form of a mixture or compound, were used by Professor Barff, were already well known and largely used almost all over the world as powerful antiseptics for almost every preparation of food and drink with which we were acquainted. Glycerine was largely used as a preservative of meat, fruit, wine, beer, and a variety of other things, and all who had any hospital practice knew that, either in a concentrated or diluted state, it was one of the best liquids in which to preserve pathological specimens. Not only had both these substances been known as preservatives, but the case of borax and boracic acid in glycerine had been described in several English journals, some years ago. But granting that boracic acid on the one hand, and glycerine on the other, produced certain effects, if when combined they had an enhanced effect, Professor Barff was certainly entitled to their thanks for the discovery; but he would submit that no crucial experiment in support of that portion had as yet been placed before them. They had not heard that a certain weight of meat had been preserved by so many ounces of this compound, which had not been preserved by an equivalent weight of glycerine or borax, nor had they heard whether, as he thought might be the case, if instead of taking the trouble to make this beautiful glacial-like substance, they simply used boracic acid in glycerine, in the manner suggested in several journals, the same effect would not be produced. Again, the influence of boracic acid for good or evil on those who took it internally, had not by any means been decided; he believed there had been some opinions laid before the Academy of Sciences of Paris, which would go some way to prove that boracic acid, taken in moderately large quantities for a long time, was calculated to produce rather grave results in the animal economy. He should be glad if Mr. Barff would state what proportion of these ingredients he proposed to use, and found most effectual, more especially the minimum quantity which would produce a certain definite effect. They did not want to indulge in boracic acid *ad libitum*, and to take half an ounce if one-fourth of an ounce would do. Some thirteen years ago, he exhibited in that room samples from Jamaica, from America, and from the South of Ireland, and other places, of substances preserved with very small quantities of antiseptics—bisulphide of carbon amongst them—which were partaken of, apparently, with great gusto. With regard to turtle, which had been specially mentioned, he would say, that there was no great difficulty in preserving any of the gelatinous class of fish, and he could name, almost at random, six or seven substances which would do so in very small quantities, for instance, salicylic acid, which acted powerfully in far more minute quantities than the compound now described; something like $\frac{1}{2000}$ part was amply sufficient for the many organic substances for from six months to two years. If that were so, and there were no particular objections to its use, he failed to see the commercial advantages of this new compound which had been so ably described.

Admiral **Selwyn** desired to traverse one or two statements which had been made. Having had a large experience of salt meat, he utterly denied that people liked it, or that it was nutritious. He never saw a sailor yet who would not eat a boiled leg of mutton in preference to salt junk, and he was quite certain that, although we did turn out very good men from the navy, it was not by dint of the enormous quantity of salt junk they ate, but in consequence of the modern contributions of fresh meat which were given them. They used to suffer often from scurvy on account of their diet, and you might have too much of even such a good thing as salt. But salt would not do what was wanted; it would not give the people of this country anything new; they knew all about salt meat, and he failed to see that that was any answer to the real question now before the public, which was, how to bring from those countries which produced it the enormous quantities of food which they were capable of supplying at a really cheap price. In the Rocky Mountains he never failed to have the finest beef driven up to the mine, 7,000 feet above the sea level, at 1½d. per pound, and that could be transported to this country at a profit for 2½d. or 3d. It was now contracted to be done for 20 dols. the carcase. It was absurd to suppose that our home production of meat could go on by the side of that, unless some farmer would show them how to produce a full grown bullock for £5. This meat was now sold at 4d. a pound by the carcase, but it never reached the small consumer at that price. If he could be supplied without danger of waste in the joint, even from Liverpool, he would get it for under 4d.; but he had at present no hopes of doing so, because the middleman stepped in and prevented him. This was the great importance of any new mode of preservation, particularly where it left the flavour perfect. As for saying that because salicylic acid and other things had been found to answer, therefore they should not welcome another form, he failed to see any reason in it. Each atom contributed to the science of food preservation had its value, and they might safely leave commercial men to make choice of the method which was, on the whole, best. Perhaps the most interesting experiment was that on the lobsters, for he did not believe anyone had yet succeeded in keeping lobsters for such a length of time in any preservative; most of them substituted for one bad smell another equally bad. He knew Mr. Barff had taken up this question in the pure spirit of research; he brought it forward, and told them as much as he could about it, and he could not be expected in the first paper to give every matter of detail; but he had promised, as his experiments went on, to give the results. He had no doubt that, as he went on, he would make further improvements, and it was not air to ask for the full result of his labours at once.

Dr. **Allchin** said he was not so much concerned with the commercial aspect of the question, but he spoke as a hospital physician; and he would impress on Mr. Barff the desirability, in bringing this subject before the public, of making absolutely clear, that the ingredients he used were not in the slightest degree deleterious. They were well aware how suspicious the public were of any changes with regard to their food; and it was of the utmost importance that some crucial experiments should be tried of an authoritative character, that would show the effect of this material, which he had every reason to believe was perfectly innocuous, in different doses. He thought Dr. Thudichum, in referring to salt meat, had somewhat drawn a red herring across the track of the discussion. Putting aside Professor Voit's experiments, it was generally assumed that the process of salting meat did materially reduce its nutritive value; and though he would accept the fact on Dr. Thudichum's authority, that those fears had been exaggerated, he was perfectly sure that salted meat, however nutritious it might be, was less digestible. But salt meat was one thing and this practically fresh meat was another; and it was not because we had salt meat that we should go on with that, and should not investigate other methods, such as this, for the purpose of supplying fresh meat. It struck him that there was one important use for this material which had not been referred to, and that was this:—There was a very pressing necessity for something which would keep morbid specimens for museums, and would preserve their colour, and Mr. Barff would have conferred a great benefit on a small but not unimportant class—medical men—if he provided them with a material which would accomplish this. So far as he could see, the specimens on the table seemed to have preserved their colour, and if it was applicable to morbid specimens, it would be of considerable value.

Mr. **Clements** did not agree with Mr. Barff that the juice of meat did not require digestion, and also feared that the boron taken into the system might have some deleterious effects.

Mr. **Dipnall** said he could not claim to be a scientific man, but he was interested in a great institution, where the feeding of a very large number was a matter of supreme importance, and he should like to ask a few practical questions. He wished to know whether the meat or other substances must be immersed in, and permeated by, this mixture, or whether it acted as a kind of paint which sealed within the substance itself its own food properties, and preserved them intact. Also whether this would keep good like a bath of salt, so as to be used again and again; or whether, having been once used, it must be thrown away. Another point was the time occupied in making the process effective, and if it could be applied under pressure, so as to accomplish in a few minutes what would otherwise occupy some hours. Lastly, it was important to know whether it could be applied, not by scientific persons, but by those who conducted ordinary domestic operations.

Mr. LIGGINS said it was his duty, for many years of his life, to see that the ships of his father and himself were properly victualled for voyages of from three to five months, and he had, therefore, some experience in meat. In his opinion the viands before them, both cooked and uncooked, were in an admirable state as far as the eye could judge. From the description given he should think any one could use this process without any scientific apparatus, and, therefore, it was a matter of general utility. He had often, when in the West Indies, enjoyed the preserved products of this country and the United States, and had eaten many good joints of meat which had been six weeks at sea; they were preserved in ice—not frozen—and retained their flavour very well. He was not surprised, therefore, at another process, which was capable of bringing things from Jamaica, particularly the fruits. He did not see why there should be any comparison drawn between salt meat and this, though his experience did not quite agree with Alderman Selwyn's; he believed sailors in the merchant navy would be very much offended if their salt meat were withdrawn. He was aware, from reading Cook's and Anson's voyages, that scurvy was once the great scourge of the merchant navy, but there were reasons for that which no longer existed; the voyages were not so long, medical science had very much advanced, and matters of diet were much better understood. He had seen many a turtle killed in the West India islands, and it had to be cooked within an hour. It would be a great saving if what was not immediately required could be preserved for future use, instead of being thrown away. The same with meat; it was the custom there, before an ox was killed, to arrange who should take the different joints, but if those not required immediately could be preserved, it would be a great saving to housekeepers, and a convenience as well.

Professor BARFF, in reply to the various questions which had been asked, said he had used salicylic acid, and had found it useful in preserving food, but for several reasons discontinued further investigations, one being on the score of its wholesomeness, and he found that his views on that point had been borne out by the action taken by the French Government. Dr. Graham had asked him about flavour; he had given Dr. Graham, a few days ago, some specimens of preserved fish, which he said had lost their flavour, but that would not be found to be the case with the box of sardines. The herrings had been kept in an open vessel exposed to the air ever since the day they were put into the liquid, and, therefore, it was not surprising that they had lost their flavour. If they would try any of the things which had been tinned, not soldered up, but such as the Jamaica pigeons, which were in a common corked bottle, it would be found that the aroma and flavour were retained. The only thing requisite was to keep the vessel so as to exclude the air, as you would with tea or coffee. Dr. Thudichum made some very interesting remarks which there was not time to refer to at length, if he were competent to do so, but not being a medical man, he could not enter into medical questions. As to the wholesomeness of the compound, however, he might say that he had taken large quantities of it himself, and it had never done him any harm; and a near relative had taken an ounce per week regularly for a year and a half, without any ill effect—a person, too, not very strong or of good digestive powers. The boys and teachers of Beaumont College drunk milk preserved with it without distinguishing the taste or suffering any ill effects. He knew there were medical opinions in favour of boracic acid, and one physician he was acquainted with used it as a medicine. If it were at all unwholesome, he certainly should not recommend it, but he did not think there was the slightest fear. As to boron getting into the system, it was not boron which was used, but oxide of boron; but even if it did, and he should not be surprised if traces of boron were found in the excreta, it did not follow that any harm was done. There were many things which went through the system without injury; for instance, silica, of which most people took a great deal in the 24 hours. As to the cost of the process, the cost per gallon, as far as he could tell—he could not say exactly—would be under 1s.—perhaps 8d. or 9d.—and a gallon would affect an enormous quantity. Most of the articles on the table were put into one pan of solution, and the cost of the whole stuff was about 9½d. Should the process be adopted commercially, experiments as to the cost would be most carefully made, and the results published. A joint of any size could be soaked; the only thing was to give it plenty of time. You might soak a piece of beef of 20 lbs., 40 lbs., or 50 lbs.; or you might use an injecting syringe, such as butchers employed for salting meat quickly, and the meat so treated would keep for a week or a fortnight perfectly good, but he did not think it would keep well enough to pass under a tropical sun. In order to do that you must inject by the aorta, by means of a force-pump, so as to sent the liquid into all the interstices of the flesh. As to the proportions, 1 in 20 was the strongest he used, and 1 in 60 the weakest; for preserving meat, 1 in 50 answered perfectly well—1 lb. of the compound added to 50 lbs. of water. The bottle should be put before the fire until melted, and then poured into hot water, and it would dissolve. With regard to preserving morbid specimens, he thought it would answer perfectly well. He had had some practice in morbid anatomy, and he might say that, for the injection of bodies to be used for anatomical purposes, it would keep them perfectly sweet. It should be injected by the aorta in the usual way before injecting with the red wax. In reply to Mr. Dipnall, he would say that compound penetrated right through into the innermost parts of the meat. If you had an earthen pan and put into it 1 lb. of this and 50 lbs. of water, and placed in it a joint which came home on the Saturday night in hot weather, you could take it out the next day and it would keep perfectly for a fortnight. Of course it took time to penetrate into the meat, but the first superficial penetration stopped the injurious effects of germs which set up putrefaction. Another important fact was this, if you had a roast leg of lamb, perfectly good, but did not eat it all, and put it away in hot weather it would turn sour, but if it had been treated in this way it would not; it would keep for six months without going sour. By adding a small quantity from time to time, which you could only learn by experience, the bath would keep perfectly fresh and effective; though it would be found after a time to get rather dark coloured. That arose from the juice of meat, and the advantage of this process was that you need not throw it away, as you must brine, but could boil it down into very good soup. In conclusion, he would only ask his hearers to read the paper and discussion carefully when published, and he was sure any one would be able to carry out the process.

The Chairman, in proposing a hearty vote of thanks to Professor Barff, said the process he had described was remarkable for its great simplicity, and the ease with which it could be carried out. Any cook could readily apply it.

The vote of thanks was carried unanimously.

Miscellaneous.

PARCELS POST.

On Monday, the 27th inst., Mr. Fawcett made the following statement in the House of Commons, in answer to a question put to him by Mr. Monk, as to the intention of the Government with respect to the introduction of a parcels post into this country :—

At the beginning of the Session I stated that I was about shortly to submit certain proposals to the Treasury for the establishment of a parcels post. These proposals have now been sanctioned by the Treasury, and the House may, I think, be interested to hear their character. It is proposed that parcels should be posted at any post-office of the United Kingdom where letters are received, and that the postage being prepaid, they should be delivered free of further charge wherever letters are delivered. The *maximum* weight will be 7 lb., for which the proposed charge will be 1s., less rates of postage being charged for parcels of lower weight. If this inland parcels post is established it will immediately be linked with the international parcels post which is now in operation. This will enable parcels to be posted from any part of the United Kingdom to every other country in Europe except Russia, and to Egypt and Asiatic Turkey. I will not trouble the House by giving details of the rates of this international parcels post, but I may state as an illustration, that if our arrangements are carried out, a parcel not exceeding three kilogrammes (about 6½ lbs.) in weight may be posted from any part of the United Kingdom to any part of France, for a charge which cannot exceed 1s. 9d. I believe great advantages will result to the entire community from the establishment of a parcels post, and I am glad to think that the rural districts will largely participate in these advantages, because at the present time, if it be desired to send a parcel to some village away from a railway station, it is often impossible to ascertain beforehand when the parcel will arrive, and how much the person who receives it will have to pay for its delivery. I will only further add that steps have been already taken to put the Post Office in communication with the railway companies, with the object of giving effect to the scheme. It will be obvious to the House that time will be required to complete the necessary arrangements for introducing so important an extension of the present postal system as a parcels post. I will, however, give an assurance that no effort shall be wanting on the part of the Post Office to bring the scheme into operation with the least practicable delay.

UTILISATION OF BLAST-FURNACE SLAG.

The attention of foreign scientific men has lately been directed to the utilisation of slag, a subject which was dealt with by Mr. Charles Wood in a paper read before the Society of Arts in May, 1880.

According to M. A Gounod, a blast-furnace produces an average of rather more than 25,000 cubic yards of slag yearly, which piled up to the height of a metre, or rather more than a yard, covers a space of 2½ hectares, or about six acres, which is completely lost for any useful purpose. If the slag be piled up to a greater height, an additional expense of nearly two francs per ton is incurred; therefore, many methods have been proposed for turning it to some profitable use. The composition of the scoriæ is such, that it is impossible to use it without admixture with other substances. The following has been proposed and tried; but each has its objections :—

1. The metalling (macadamising) of roads; but slag, having no great cohesion, soon becomes reduced to a state of powder, and is blown away by the wind.

2. Use in blocks for the construction of dikes and sea-walls, the slag being allowed to run into iron moulds; but it is feared that the sea-water would eventually bring about a partial decomposition capable of causing a falling in.

3. Manufacture of paving stones, for which purpose the slag is run into suitably shaped moulds, and the blocks are afterwards worked into a cubical form. This, however, involves considerable expense.

4. Manufacture of mineral felt. Subjected to the action of a strong current of air, slag forms woolly filaments, which are used for covering steam-boilers and pipes for preventing the radiation of heat. It has, however, been found that only slag of a certain

composition is suitable for this purpose, as otherwise the felt crumbles to dust.

5. It has also been proposed to make rough bottle-glass by melting the slag in a Siemens furnace, with suitable proportions of sand or an alkali; but the results obtained have not been satisfactory.

The most practical and successful methods hitherto employed for turning slag to useful account, besides preventing its becoming a nuisance and an eyesore, is to make it into bricks and mortar for building purposes. By granulating it, and allowing it to fall into a stream of cold water, a sand is formed, which, with the addition of lime or gypsum, may be made into either bricks or mortar. The strength of bricks thus produced is greater than that of the best bricks of Burgundy, and their price on the spot is about 37 francs (£1 10s.) per thousand.

SILK-PRODUCING AND OTHER BOMBYCES REARED IN 1881.

By Alfred Wailly.

(Membre-Lauréat de la Société d'Acclimatation de France.

Part II.

Attacus Cynthia, from the province of Kumaon.—With the *Atlas* cocoons, a large quantity of *Cynthia* cocoons were collected in the province of Kumaon. Both species had, no doubt, fed on the same trees, as the *Cynthia*, like the *Atlas* cocoons, were all enclosed in leaves of the *Berberis vulgaris*, which shows that *Cynthia* is also a polyphagous species. It is already known that it feeds on several species of trees, besides the ailanthus, such as the laburnum, lilac, cherry, and, I think, also on the castor-oil plant; the common barberry has, therefore, to be added to the above food-plants.

These Kumaon *Cynthia* cocoons were somewhat smaller and much darker in colour than those of the acclimatised *Cynthia* reared on the ailanthus. The moths of this wild Indian *Cynthia* were also of a richer colour than those of the cultivated species in Europe.

During the summer 1881, I saw cocoons of my own *Cynthia* race obtained from worms which had been reared on the laburnum tree. These cocoons were, as far as I can remember, of a yellowish or saffron colour, which I had never seen before. This difference in the colour of the cocoon was very likely produced by the change of food, although it has been stated, and I think it may be quite correct, that with many species of native lepidoptera the change of food-plants does not produce any difference of colour in the insects obtained. With respect to the *Cynthia* worms reared on the laburnum instead of the ailanthus, it may be that the moths, which will emerge from the yellow cocoons, will be similar to those obtained from cocoons spun by worms bred on the ailanthus, and that the only difference will be in the colour of the cocoons.

The Kumaon *Cynthia* cocoons, as I found it to be the case with Indian species introduced for the first time into Europe, did not produce moths at the same time, nor as regularly as the acclimatised species. The moths emerged as follows:—One female on the 22nd of July; one female on the 25th, one male on the 3rd August; one female on the 19th; one male on the 28th of August; one male on the 2nd September; one female on the 3rd. A pairing was obtained with the latter two. Two males emerged on the 4th of September; one male on the 6th; one male and one female on the 22nd; one female on the 23rd, and one female on the 25th of September. Five cocoons, which did not produce any moths, contain pupæ, which are still in perfect condition, and the moths will no doubt emerge next summer (1882). As seen in my note, a pairing of this wild Indian *Cynthia* took place; this was from the evening of the 4th to the 5th of September. The eggs laid by the female moth were deposited in a most curious way, in smaller or larger quantities, but all forming perfect triangles. These eggs I gave to a florist who has been very successful in the rearing of silk-producing and other larvæ, telling him to rear the *Cynthia* larvæ on lilacs grown in pots and placed in a hot-house, which was done. The worms, which hatched in a few days, as they were placed in a hot-house, thrived wonderfully well, and I might say, they thrived too well, as they grew so fast and became so voracious that the growth of the lilac trees could not keep pace with the growth of the worms. These, at the 4th stage, became so large that the foliage was entirely devoured, and, of course, the consequence was that all the worms were starved. I only heard of the result of that experiment long after the death of the larvæ; otherwise I should have suggested the use of another plant after the destruction of the foliage of the lilacs; the privet (*Ligustrum vulgare*) might have been tried, and success obtained with it.

Of such species as *Attacus Pyri*, of Central Europe, and *Attacus Pernyi*, the North Chinese oak silkworm, which I have mentioned in my previous reports, and bred every season for several years, I shall only say that I never could rear *Pyri* in the open air in London, up to the formation of the cocoon. As to *Pernyi*, I had, in 1881, an immense quantity of splendid moths, from which I obtained the largest quantity of ova I ever had of this species. I had many thousands of fertile ova of *Pernyi*, which I was unable to distribute. Many schoolboys reared *Pernyi* worms, but with what success I do not yet know. The number of fertile ova obtained from *Pyri* moths, was also more considerable than in former years, which was due partly to the good quality of the pupæ, and partly to the very favourable weather in June, at the time the pairings of the moths took place.

Leaving these, I now come to the North American species.

Telea Polyphemus.—As I have stated in former years, this is the best North American silkworm, producing a closed cocoon, somewhat smaller than that of *Pernyi*, but the silk seems as good as that of *Pernyi.*

The cocoons of *Polyphemus* I had in 1881 were smaller and inferior in quality to those I had before. Those received in 1878 and 1879 were considerably finer and larger than those which were sent in 1880 and 1881; besides, they were sent in much larger quantities. The cocoons received this year (1882) are finer than those of 1881, but yet they cannot be compared with those of 1878 and 1879.

With about sixty cocoons of *Telea Polyphemus*, I only obtained three pairings, which I attribute solely to the weakness of the moths, as the weather was all that could be desired for the pairings. The moths emerged from the 1st of June to the 20th of July. One male moth emerged on the 7th September. This latter was one from a small number of cocoons received from Alabama; the other cocoons of the same race had emerged at the same time as the cocoons from the Northern States. In the Northern States the species in single-brooded; in the Southern States it is double-brooded.

The larvæ of *Polyphemus* can be bred in the open air in England, almost as easily as those of *Peryni* and even *Cynthia*; they will pass through their five stages and spin their cocoons on the trees, unless the weather should be unexceptionally cold and wet, as was the case during the month of August, 1881, when the larvæ had reached their full size; they were reared this year on the nut tree, and some on the oak. The species is extremely polyphagous, and will feed well on oak, birch, chesnut, beech, willow, nut, &c.

The moth of *Polyphemus* is very beautiful, and, as in some other species, varies in its shades of colour. The larva is of a transparent green, of extreme beauty; the head is light brown, without any black dots, as in *Pernyi*; the spines are pink, and at the base of each of them, there is a brilliant metallic spot. When the sun shines on them the larvæ seem to be covered with diamonds. These metallic spots at the base of the spines are also seen on *Pernyi*, *Yama mai*, *Mylitta*, and other species of the genus *Antheræa*, all having a closed cocoon, but none of these have so many as *Polyphemus.*

The cocoons of the species of the genus *Actias* are closed, but the larvæ have not the metallic spots of the species of the genus *Antheræa.*

EDUCATIONAL PROGRESS IN JAPAN.

The following is extracted from a letter to Mr. T. Twining, from J. Tegima, the Curator of the Tokio Educational Museum:—

"Our Department of Education established the Educational Museum some years ago, in which the school materials and scientific apparatus, &c., mostly of a popular character, are exhibited, and into which the public have free admission all the year round. This year we propose to have a separate exhibition building built, to display such apparatus as is necessary for illustrating the science of daily life, as well as industrial education.

"I send you our catalogue of the Zoological and Botanical Collections, which I hope you will accept. I am sorry not to send you more by way of exchange, but the rest are printed all in the Japanese."

PURIFICATION OF WATER.

The process devised by Mr. Peter Spence, of the Manchester Alum Works, for purifying inferior discoloured water, has been lately tried on a large scale at the Water Works of the Bolton Corporation, and the result is reported in the local papers as thoroughly satisfactory. The Bolton water is said to contain a proportion of micaceous clay in such a state of suspension, that neither filtration nor long settlement in reservoirs will remove its dirty opaque tint. The trial has been made at the Heaton reservoir, one of the two service reservoirs supplying Bolton and district; the other, the Sweetlove's reservoir, having been left untouched. The result of the trial is reported to be that, whereas the latter contains a mass of water which, upon being looked at through the two-feet tube, over white paper, would be pronounced unfit for drinking purposes, the Heaton reservoir now contains some sixty million gallons, which is transparent and colourless. It may be added that this result has been achieved without in the least degree hardening the water or introducing any new constituent into it, or without in any way affecting the fish in the reservoir; and the cost of treatment so far is stated not to exceed one halfpenny per head per annum of the population. Mr. Spence claims the additional merits for his process, that it can be controlled with the greatest ease and certainty by a test which any labourer can be readily taught; that the unskilled labour of one man for a few minutes per day is all the work it requires; and that the total cost of treatment per million gallons is insignificant in comparision with the gain resulting from transforming dirty into clear colourless water.

Dr. Angus Smith, H.M. Chief Chemical Inspector under the Alkali Act and the Rivers Pollutions Prevention Act, and one of our leading authorities on the impurities of air and water, has it appears tested the clarifying and decolorising influence of the process upon the Manchester water, with the following results:—Distilled water, 33; Manchester water, treated, 32; and Manchester water, untreated, 14. Dr. Smith also considers that a notable proportion of the pernicious, though invisible, albuminoid matters would be removed, along with the coloured and mechanical impurities.

Correspondence.

TEA AND SILK FARMING IN NEW ZEALAND.

It will doubtless afford some gratification to those of the members of this Society who take an interest in the proposal to inaugurate tea and silk farming in New Zealand, to learn that the suggested enterprise is not unlikely soon to become an accomplished fact. From the *Thames Advertiser* of 28th January, it appears that at a public meeting held in a northern part of Auckland, steps were taken to form a joint-stock company for the purpose of commencing sericiculture on an area of four acres of land, and that 400 shares were subscribed for on the spot. More recently, the *Colonies and India* of 24th February stated that the "Auckland Acclimatisation Society" had engaged a practical tea grower to test the remunerative capabilities of tea production in the colony. Whilst both these efforts are eminently laudable, and deserving the sympathy and encouragement of every well-wisher to the industrial progress of New Zealand, it is quite permissible to ask, why have our Antipodean friends failed to see the economical necessity of conducting their experiments side by side on the same land, and under the same general oversight, by amalgamating their forces? On this important point, a correspondent with Indian experience, thus advises the *New Zealand Times* of 12th January—"In Kangra Valley the silk season happens just at the tea-planters' slack time, and therefore, silk rearing may be undertaken without clashing with the interests of the tea plantations, and might, indeed, help these, by keeping the labour together. Add to these two considerations this other, that tea, as a rule, requires shade, and that the mulberry does the tea underneath it no harm, and we have a combination which ought to render the spread of cultivation for silk rearing as rapid as it is profitable." It is only in the close union of the two industries in New Zealand, where labour is at present expensive, that success in any degree need be anticipated; united and conducted together as one enterprise, the result cannot fail soon to afford the amplest financial satisfaction. Until experience on the spot has authorised the quotation of actual results, it would be rash, and might prove misleading, for any one to indicate what the profit is likely to be. Nevertheless, it may be fearlessly asserted that, should the return even approach the yield obtained from some specially well-managed private tea-gardens in India, and elsewhere, and some mulberry plantations in California, and other places, the income per acre will far transcend that obtainable from any and every kind of agricultural product with which either the home or colonial farmer is now acquainted. As yet, the arrangements for the promotion of an influential public company in this country to carry out tea and silk farming in New Zealand, in its full integrity, are not complete.

WILLIAM COCHRAN.

Dunblane, 22nd March, 1882.

General Notes.

RECLAMATION OF LAND IN THE CAMPAGNA OF ROME.—The results obtained by the Trappist monks at the Monastery of the Tre Fontane, clearly shows what may be accomplished by perseverance and energy. The monastery, which is situated at a short distance outside the walls of Rome, on the road to Ostia, was, only a few years ago, one of the most unhealthy spots in the Campagna, and so fatal was the climate that the monks were compelled to reside in Rome during the summer months, and every one of their number was, in turns, stricken down by fever, to which many of them succumbed. As a beginning, the monks commenced to plant the marshy neighbourhood of the Tre Fontane with the *Eucalyptus*, and by means of this tree, which absorbs from the soil a large quantity of moisture, many acres of land have been freed from stagnant waters, which during the summer months tended to make this spot one of the most deadly in the whole of the Roman Campagna, and gain for it the appropriate title of "Il sepolcro." The soil, in many places, had become so hard as to defy the action of the spade and pick, and the resolute Trappists were obliged to blast the hard crust, beneath which a rich virgin soil was found. Drains were cut and channels made to carry off the waste water, and all the time they had to fight against fever. Fresh contingents of friars continued to arrive from the central monastery of the Grande Trappe, and, eventually, the indomitable energy of the abbot and his coadjutors, succeeded in vanquishing obstacles which, at the outset, had appeared insurmountable, and the agricultural labours of the monks have resulted in an actual change in the climate of the Tre Fontane, and all things around now speak of work, skill, and cheerfulness.

ELECTRIC LIGHTING IN ITALY.—The administration of the Alta Italia Railway Company, has decided to light the Milan Railway Station by electricity in the place of gas. It is proposed to light this building with 4 large lamps to develop in all 24,000 candle power. The cost is estimated at 66,550 lire, whilst the annual expenditure will be 15,168 lire.

JAMES BARRY.—The *Cork Constitution* has lately published some Reminiscences of the Cork Industrial Exhibition of 1852, which contains a notice of James Barry, who was a native of Cork. The picture exhibited at the Cork Exhibition was an allegorical portrait of the Prince Regent, as St. George in triumph after having overcome the dragon.

POPULATION OF THE PRINCIPAL TOWNS OF ITALY.—The results of the census taken on the 31st December, 1881, have as yet been only partially published by the Statistical Department. It appears that the total population of the 69 chief provincial towns in Italy was 4,103,887 in 1871, as compared with 4,504,006 in 1881, showing an increase of 400,119, or at the rate of 9·75 per thousand during the last ten years. The following shows the number of inhabitants in some of the principal towns at the 31st December, 1881, as compared with the census ten years previous, together with the increase during that period:—

	1881.	1871.	Increase in No.	Increase per 1,000.
Naples	494,015	448,335	45,680	10·19
Milan	321,539	261,985	59,544	22·73
Rome	300,467	244,484	55,983	22·89
Turin	252,832	212,644	40,188	18·90
Palermo	244,955	219,398	25,557	11·65
Genoa	179,491	161,669	17,822	11·02
Florence	163,112	167,093	Note	—
Venice........	132,826	128,901	3,925	3·04
Messina	126,497	111,854	14,643	13·09
Bologna	123,274	115,957	7,317	6·31
Catania	101,499	84,397	17,102	20·26
Leghorn	97,615	97,096	519	0·53

NOTE.—Florence shows a decrease in the number of inhabitants of 3,981, or 2·39 per thousand from 1871 to 1881, on account of the removal of the capital to Rome, whilst from 1861 to 1871, it had increased at the rate of 16·67 per thousand.

PARCELS POST IN ITALY.—Since the 1st October, 1881, parcels not exceeding 3 kilogrammes (6½ lbs.) in weight, and subject to certain limits of dimensions, that is to say, not exceeding 60 centimetres (2 ft.) in length and 20 decimetres cube (220·54 cubic inches) in capacity, are conveyed through the kingdom of Italy for 50 cents if called for at the post-office, and 25 cents more is charged if delivered.

MEETINGS OF THE SOCIETY.

ADDITIONAL MEETING.

Tuesday Evening, at Eight o'clock:—

April 4th.—"Animal Locomotion." By Mr. MUYBRIDGE. (See notice on p. 515).

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 3...Chemical Industry (London Section), Burlington-house, W., 7½ p.m. 1. Mr. C. F. Cross, "The Chemical Technology of Jute Fibre." And time permitting (2), discussion on "Smoke Abatement."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m Mr. C. W. Richmond, "Materialism."

TUESDAY, APRIL 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Exhibition by Mr. Muybridge of his Photographs of Animals in Rapid Motion.

Shorthand, 2, Falcon-court, Fleet-street, E.C., 8 p.m. Mr. Edward Pocknell, "The Principles of Legible Shorthand."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Dugald Clerk, "The Theory of the Gas-engine."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. C. Staniland Wake, "The Papuans and Polynesians." 2. Mr. C. Pfoundes, "Rites and Customs in Old Japan."

Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. A. Günther, "Description of a New Species of Tortoise (*Geoemyda impressa*) from Siam." 2. Mr. W. A. Forbes, "On the Convoluted Trachea of Two Species of Manucode, with Remarks on the Tracheas of other Birds." 3. Mr. J. E. Harting, "On the Eggs of Some Rare Wading Birds from Madagascar." 4. Mr. E. P. Ramsay, "Description of a New Species of the Genus *Tephras*."

WEDNESDAY, APRIL 5...Geological, Burlington-house, W., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Rev. Dr. Sparrow Simpson, "A Tonsure Plate formerly used by the Ecclesiastics of St. Paul's Cathedral." 2. Sir Lewis Wincopp Jarvis, "Myddleton Towers."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, APRIL 6...Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. H. Perkin, "Observation on the Action of Acetylic Chloride on Fumaric Acid." 2. Mr. J. Emerson Reynolds, "Note on a convenient Apparatus for the Liquefaction of Ammonia." 3. Mr. H. J. H. Fenton, "Transformation of Urea into Cyanamide." 4. Mr. M. K. Dutt, "Some Arguments in favour of Ladenberg's Prismatic Formula of Benzene."

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. G. S. Ely, "The Algebraic Solution of the Modular Equation for the Septic Transformation." 2. Mr. T. Muir, "Note on the Condensation of Skew Determinants which are partially Zero-axial, and on a Symmetric Determinant connected with Lagrange's Interpolation Problem." 3. Rev. M. M. U. Wilkinson, "The Analogues to the Addition Equation for Theta Functions."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Francis Darwin, "The Connection between Geotropism and Growth." 2. Mr. R. Bowdler Sharpe, "Birds of New Guinea." 3. Mr. B. Daydon Jackson, "Notes on a Negative Heliotropism." 4. Rev. R. Boog Watson, "Mollusca of the *Challenger* Expedition."

FRIDAY, APRIL 7....Geologists' Association, University College, W.C., 8 p.m.

SATURDAY, APRIL 8....Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, APRIL 7, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANIMAL LOCOMOTION.

On the evening of Tuesday last, April 4th, Mr. Muybridge explained the results of his researches on "Animal Locomotion," and illustrated these by an exhibition of his photographs of animals in rapid motion, which were thrown upon the screen by means of the electric light. The different motions of horses in the acts of trotting, ambling, cantering and galoping, were thus shown, also the motions of the dog, the ox, the pig, and the deer. Men were exhibited walking and jumping, animals in groups, and, finally, birds on the wing. After the distinct motions had been shown separately, they were combined by means of Mr. Muybridge's new instrument, the "Zoepracticocope," and the animals were shown as though in movement across the screen.

Ths Chairman (Dr. R. J. Mann, F.R.C.S.) proposed a vote of thanks to the lecturer, which was carried unanimously.

The lecture will be printed in the next number of the *Journal*.

CHANNEL TUNNEL.

As it is probable that many members will wish to attend the discussion on the Channel Tunnel, to be opened by Sir Edward Watkin on the 19th inst., it has been thought desirable to make special arrangements for the meeting. The usual rules for the admission of members and their friends will therefore be suspended. Admission will be by ticket only, and no person, whether a member or not, can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued to members desiring them, in the order in which they apply. Each ticket will admit one person, and is transferable. Not more than a single ticket can be issued to any one member. It is hoped that all members who apply in good time may be accommodated ; they should, however, apply at once to the Secretary.

By order,
H. Trueman Wood, *Secretary.*

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1882, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Professor Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (now Sir Joseph) Whitworth, F.R.S., LL.D.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Ferdinand de Lesseps, Member of the Institute of France.

In 1871, to Mr. (now Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., LL.D., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D. D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, Member of the Institute of France.

The Council invite members of the Society to forward to the Secretary, on or before the 22nd of April, the names of such men of high distinction as they may think worthy of this honour.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, March 13, 1882; Dr. J. H. GILBERT, F.R.S., in the chair.

The paper read was—

SOME PRACTICAL ASPECTS OF RECENT INVESTIGATIONS ON NITRIFICATION.

By Robert Warington.

If we wish to control the operations of nature, we must, in the first place, endeavour to understand them. Until we are acquainted with the mode in which any particular action takes place, and the influence exerted by varying external conditions, we are not in a position to govern the course of the action, or to employ it in our service.

That nitrates are continually being produced in soils, and especially in the soils of the hotter regions of the globe, has been long known; the saltpetre exported from India since early times is a familiar instance of the fact. Chemists were not slow in perceiving that the production of nitrates in the soil was due to a process of oxidation; they ascertained that ammonia and the nitrogen of organic bodies were oxidised in the soil, nitric acid being produced. In what manner, however, this oxidation was brought about, remained unknown till a few years since.

It was early in 1877, that two French chemists, MM. Schlœsing and Müntz, published some experiments proving that nitrification in soil is due to the action of a living ferment. These chemists have since pursued the investigation of the subject with much success; the inquiry has also been taken up at Mr. Lawes's laboratory at Rothamsted, the results obtained being entirely confirmatory of the theory just mentioned.

The facts on which this theory rests may be briefly stated. Dilute solutions of urine, or of ammonium salts, containing the essential constituents of plant food, undergo no nitrification, though freely exposed to air, if only they have been previously boiled and the air supplied to them is filtered through cotton wool. If to such sterilised solutions a small particle of fresh soil is added, no action at first appears, but after a while active nitrification sets in, and the ammonia or urea is converted into a nitrate. For the production of nitric acid it is necessary that some base should be present with which the nitric acid may combine. The action proceeds best in the dark. When a solution has thus undergone nitrification, a drop of it suffices to induce nitrification in another solution, which, unless thus seeded, would have remained unchanged. Boiling the soil, or the solution that has nitrified, entirely destroys its power of causing nitrification. The presence of antiseptics also prevents nitrification. Lastly, nitrification is confined to the same range of temperature which limits other kinds of fermentation. The production of nitrates proceeds very slowly near the freezing point, but increases in rapidity as the temperature rises, reaching its maximum of energy, according to Schlœsing and Müntz, at 37° C. (99° Fahr.). At higher temperatures the rate of nitrification rapidly diminishes; it almost ceases, according to the same observers, at 50° C. (122° Fahr.), and at 55° C. (131° Fahr.) no change occurs. It thus appears that nitrification can only be produced in the presence of some nitrified or nitrifying material, and the whole course of the action is limited to the conditions suitable for the activity of a living ferment. The French chemists claim to have isolated the ferment by systematic cultivation; it belongs to the family of *Bacteria*.[*]

We must not dwell to-night on the many points of scientific interest involved in these researches. I may remark, however, that we have here the first instance in which the action of living ferments has been shown to extend to inorganic bodies, and that a new and promising field of inquiry is thus apparently opened out.

The conditions required for the production of nitrates in soil being now much better understood than formerly, we ought to be in a position to conduct with greater success several operations in which nitrification is the principal action involved. I propose this evening to glance at two operations of this description which are of considerable practical importance, and afterwards to lay before you the results of some recent investigations by Mr. Lawes, Dr. Gilbert, and myself, in which the subject of nitrification has been regarded in its relations to agriculture.

The construction of artificial beds of soil, with the special object of producing nitre, has been carried out to a large extent upon the continent of Europe; indeed, for a very long period, these beds were the principal source of saltpetre in France, Germany, and Sweden. The process was a very tedious one. The first step was to obtain a quantity of mould rich in nitrogenous matter; this was then formed into heaps, great care being taken to keep the mass very porous, so as to admit free contact with air. These heaps of mould were protect from rain, and continually watered, first with urine, afterwards with plain water, the amount of water being carefully regulated so as to keep the soil thoroughly moist, but not sodden. At the end of two years the soil was sufficiently rich in nitrates to be worth extracting with water; 1,000 lbs. of the nitrified soil would then yield about 5 lbs. of nitre.[*] The soil, after washing, was again mixed with animal manure, and used for a fresh nitre-bed. Since the discovery of German potash salts, nitre-beds have been discontinued, salpetre being now made by the action of chloride of potassium on nitrate of sodium.

With our present knowledge of the conditions suitable for nitrification, we cannot fail to see that one reason of the slow nitrification observed in the old nitre-beds, was the low temperature at which the operation was carried out; with a higher temperature the action would have been far more speedy. It was found at Rothamsted that while a solution kept at 11° C required 37 days for nitrification, in a similar solution at 30° C the operation was completed in eight days. Schlœsing and Müntz record a still greater effect from a rise of temperature; they state that at 37° C nitrification is ten times more rapid that at 14° C.

In Europe, the temperatures most favourable to nitrification cannot be attained without the employment of an artificial source of heat, but in the Tropics such temperatures are commonly reached; tropical countries are, therefore, those most suitable for the production of nitre. A few months of a tropical temperature would perform the work requiring years in Europe. In India, considerable quantities of nitre are prepared by simply scraping off the white crust that appears on the soil near the house drains of the villages. It is obvious, however, that the greater part of the nitrates formed in the soil must be lost, as the formation of nitre takes place chiefly in the rainy season. Why should not nitre-beds be constructed in India with the same care and skill that have been displayed in France and Germany? In India, we have the temperature requisite for speedy nitrification, we have also cheap labour, and the advantage of solar heat for evaporating saline solutions. In a dense population the material requisite is abundant. If popular prejudice against the kind of labour involved can be overcome, India might probably become a great nitre-producing country.

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[*] The investigations of Schlœsing and Müntz will be found in the *Comptes Rendus*, lxxxiv. 301; lxxxvi. 892; lxxxix. 891, 1074. The Rothamsted papers on the subject are published in the *Jour. Chem. Soc.*, 1878, 44; 1879, 429; and *Chem. News*, 1881, xlix. 217.

[*] The nitrates produced in soil are chiefly nitrate of calcium; nitrate of potassium (saltpetre) is produced by treating the extract from the soil with wood ashes, or with the carbonate of potassium prepared from them.

The next subject I would glance at touches ourselves more nearly; it is the purification of sewage by filtration through soil. The plan suggested by Dr. Frankland of the purification of sewage by intermittent downward filtration, the filter-bed consisting of a mass of soil, provided with drain pipes 6 or 7 ft. below the surface, has proved most successful. We are probably, however, now in a position to state more clearly than before what are the conditions under which the greatest success may be attained.

The purifying action of soil on sewage is probably due to three distinct actions. 1. Simple filtration, or the separation of suspended matter. 2. The precipitation and retention by the soil of ammonia, and various organic substances, previously in solution. 3. The oxidation of ammonia and of organic matter by the agency of living organisms. The last mode of action is undoubtedly the most important, as without oxidation the sewage matter must accumulate in the soil, and the filter-bed lose its efficacy.

The filtering power of a soil will depend entirely on its mechanical condition. The precipitating power of soil is, on the other hand, a chemical function, in which the hydrated ferric oxide and alumina, and the silicates of soils probably play the principal part. The oxidising power of a soil will depend partly on its mechanical, partly on its chemical, and partly on its biological condition.

It was formerly supposed that the oxidising power of a soil depended solely on its porosity, oxidation being assumed to occur by simple contact with air in the pores of the soil. We now know that a porous medium is by no means essential for nitrification; sewage may, indeed, be nitrified in a glass bottle, or when passing over polished pebbles. Though, however, porosity is by no means essential to the nitrifying power of a soil, it is undoubtedly a condition having a very favourable influence on the rapidity of the process; a porous soil of open texture will present an immense surface, covered with oxidising organisms, and generally well supplied with the air requisite for the discharge of their functions. It is doubtless owing to this fact that nitrification takes place with so much greater rapidity in a soil than in a liquid.

The sewage will itself supply the substances required for the nourishment of the oxidising organisms. One material essential to nitrification may, however, sometimes be deficient, namely, the base with which the nitric acid is to combine; without the presence of this salifiable base nitrification will speedily come to a standstill. In the case of towns supplied with hard water, the sewage may contain as much carbonate of calcium in solution as will suffice for its subsequent nitrification in the soil; but in the case of towns supplied with very soft water, this can hardly be the case, and the presence of a considerable amount of lime in the soil itself will become essential for efficient nitrification.

The organisms which effect the oxidation of organic matter are abundantly present in surface soils, but are probably absent, or nearly so, in subsoils; in surface soils they will probably be abundant in proportion to the richness of the soil in organic matter. Sewage also contains the organisms necessary for its own destruction, and under favourable conditions these may be so cultivated as to effect the purpose. A filtering medium of pure sand and limestone, treated intermittently with sewage, will, after a time, display considerable purifying powers, the surfaces becoming covered with oxidising organisms derived from the sewage. No such medium will, however, equal in effect a porous soil, rich in organic life.

It will be gathered, from the observations now made, that it would be possible to construct a filter bed having a greater oxidising power than would be possessed by an ordinary soil and subsoil. Such a bed would be made by laying over a system of drain-pipes a few feet of soil, obtained from the surface (first six inches) of a good field, the soil being selected as one porous, and containing a considerable amount, both of carbonate of calcium, and organic matter.* A filter-bed thus prepared would be far more porous than a natural soil and subsoil, and would possess active oxidising functions throughout its whole depth.

The oxidising power of soil must always be considerably greater in summer than in winter. The favourable influence of the warmer seasons of the year is apparently seen in several of Frankland's experiments on the intermittent filtration of sewage; the same influence of temperature will be plainly shown in some of the Rothamsted results. When we turn, however, to the analyses of the effluent water from irrigated land, the fact is not always manifest. We must recollect, however, that a considerable part of the nitrates produced in summer will be assimilated by the growing crops, and will, therefore, not appear in the drainage water. The oxidising power of a soil may also be in excess of the work provided for it, so that even with a low temperature the usual amount of purification may be attained. A low temperature will also affect only the oxidising functions of soil, its power of precipitating and retaining sewage matter will remain unchanged.

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* Compare Frankland's analysis of the Dursley soil, which he found to possess remarkable oxidising powers. See "Rivers' Pollution Commission (1868) First Report," page 68.

One more point may be worth notice. We have already referred to the fact that nitrification, like all other kinds of fermentation, ceases in the presence of antiseptics; the refuse of chemical works may thus, sometimes, prove a great hindrance to the purification of sewage by soil.

We turn now to some of the agricultural aspects of the subject.

The production of nitrates in soil is of the greatest importance to vegetation, nitrates being the form in which nitrogen is chiefly assimilated by plants; the abundance or poverty of nitrates in a soil thus determines to a great extent the quantity of crop which a field will produce. In a fertile soil the formation of nitrates is always in progress. It will take place most abundantly in the surface soil, as here the proportion of nitrogenous organic matter (the remains of previous vegetable and animal life) is most considerable, and the access of air most free. The production will be greatly favoured by rain and by tillage, and will be far more considerable in summer than winter. Of the quantity of nitrates produced in soils recent experiments at Rothamsted afford many examples.

In the year 1870, Messrs. Lawes and Gilbert constructed three soil drain-gauges. Blocks of soil, forming part of an ordinary arable field, were isolated by walls of brick and cement. The blocks were undermined at the depths respectively of 20, 40, and 60 inches, and supported beneath by perforated iron plates. The water percolating through the soils was collected and measured. The soil enclosed in these drain-gauges is a heavy loam with clay subsoil. The area of each drain-gauge is $\frac{1}{1000}$th of an acre. The soils of the gauges have been kept unmanured, and free from vegetation; they are thus, save as respects the absence of tillage, in the condition of an agricultural bare fallow.

Samples of the earliest drainage waters were analysed by Dr. Frankland, and the quantity of nitrates present determined. Later collections of drainage water were examined in the Rothamsted laboratory. Since May, 1877, the drainage waters have been systematically analysed; we thus know, with considerable accuracy the quantity of nitrates passing from the soil as drainage during a period of nearly five years.* The average monthly drainage from some of the gauges during five years, and its contents in nitrogen, is shown in Table I.

TABLE I.—NITROGEN AS NITRATES IN THE DRAINAGE WATER FROM THE DRAIN-GAUGES AT ROTHAMSTED, CONTAINING UNMANURED FALLOW SOIL; MEAN OF FIVE YEARS, 1877-82.

	Rainfall.	Amount of Drainage.		Nitrogen as Nitrates.			
				Per million of water.		Per acre.	
		20-in. gauge	60-in. gauge	20-in. gauge	60-in. gauge	20-in. gauge	60-in. gauge
	in.	in.	in.			lbs.	lbs.
January	1·57	1·26	1·34	9·8	11·1	2.78	3·36
February	2·85	2·74	2·39	8·6	9·8	5·30	5·29
March†	1·36	0·53	0·61	6·0	9·2	0·72	1·27
April†	2·51	1·03	1·33	9·5	9·1	2·22	2·73
May...............	2·68	0·63	0·68	11·6	12·5	1·65	1·90
June	2·62	0·56	0·62	9·3	10·5	1·19	1·47
July...............	3·04	0·75	0·68	16·4	14·2	2·78	2·17
August	4·20	1·86	1·64	15·9	14·0	6·68	5·20
September......	2·83	1·23	1·14	17.2	13·3	4·78	3·43
October	2·95	1·68	1·50	15·5	13·0	5·91	4·42
November......	3·38	2·55	2·40	11·8	11·8	6·77	6·43
December	2·51	2·01	2·01	8·9	10·9	4·04	4·97
Whole Year...	32·50	16·83	16·34	11·8	11·5	44·82	42·64
SUMMARY.							
Jan.-March ...	5·78	4·53	4·34	8·6	10·1	8·80	9·92
April-June ...	7·81	2·22	2·63	10·1	10·3	5·06	6·10
July-Sept.......	10·07	3·84	3·46	16·4	13·8	14·24	10·80
Oct.-Dec.	8·84	6·24	5·91	11·8	11·8	16·72	15·82

The amount of nitrates produced in the soil is seen by these figures to be very large; from the soil 20 inches deep we have an average of 44·8 lbs. of nitrogen per acre, equivalent to 287 lbs. of commercial nitrate of sodium, appearing annually in the drainage water. The nitrates are clearly produced most abundantly in summer. The drainage from the 20-inch gauge is seen to be poorest in nitrates from December to March; from April to June there is but little increase in strength; but with July there is a commencement of drainage rich in nitrates. The gradual washing out of the nitrates formed during the summer months renders the whole of the autumn drainage rich nitrates.

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* The details of these experiments will be found in a paper "On the Amount and Composition of the Rain and Drainage Waters collected at Rothamsted." *Journal Royal Agricultural Society*, 1881, pp. 241, 311.

† The results for these months are throughout the mean of of four years.

The variations in the strength of the drainage water at different seasons of the year are much less striking in the case of the 60-inch drain-gauge; the much greater bulk of soil in this gauge resulting in a greater store of nitrates being maintained, and a consequent equalisation of the strength of the drainage. The variations of composition due to season are best seen in the summary at the foot of the table, the irregularities of particular months being obliterated in the averages there given.

The results yielded by the drain-gauges during these five years are undoubtedly in some respects excessive, the rainfall having been unusually heavy, and the average drainage about six inches above the normal quantity. On the other hand, the soil was, undoubtedly, in an impoverished condition, having suffered loss by drainage for nearly seven years previous to the commencement of these determinations.

I will next call your attention to some determinations of nitrates in field soils, subjected to bare fallow in the ordinary way on the farm at Rothamsted. Samples of soil were taken in each case from several parts of the field, at a series of known depths. The amount of nitrogen as nitrates found at each depth is given in Tables II. and III., in pounds per acre.

TABLE II.—NITROGEN AS NITRATES IN SOIL AFTER BARE FALLOW (SAMPLED OCTOBER, 1881), IN LBS. PER ACRE.

Depth.	Clay Croft Field.	Foster's Field.
	lbs.	lbs.
First 9 inches	16·4	14·6
Second 9 inches	26·5	24·6
Third 9 inches	15·9	17·3
Total 27 inches	58·8	56·5

TABLE III.—NITROGEN AS NITRATES IN SOILS AFTER CROPPING, AND AFTER BARE FALLOW (SAMPLED SEPTEMBER 1878), IN LBS. PER ACRE.

Depth.	Agdell Field.				Hoos Field.	
	Rotation fully manured.		Rotation with superphos. only.		Unmanured wheat and fallow.	
	Beans.	Fallow.	Beans.	Fallow.	Wheat.	Fallow.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
First 9 inches	12·1	30·0	7·3	22·3	2·6	28·5
Second 9 inches	8·4	18·8	3·3	14·0	trace	5·2
Total 18 inches	20·5	48·8	10·6	36·3	2·6	33·7

The results in Table II. relate to determinations of nitrates, made last autumn, in the soil of two fields under ordinary farm culture, but bare fallowed during the summer. We here find 58·8 lbs. and 56·5 lbs. of nitrogen as nitrates per acre within 27 inches of the surface. The nitrates probably extended far below this depth, as there was no sign of serious diminution at the lowest depth examined. The maximum amount of nitrates is seen to occur in the second depth; this was owing to heavy rains preceding the time of sampling.

In Table III., we have some earlier determinations of nitrogen as nitrates in bare fallows, made on two of the experimental fields at Rothamsted. The experiments in Adgell field are on rotation. On one of the plots from which samples were taken the land is always heavily manured for turnips, and the crop fed off on the land. After turnips follows barley without manure; the plot is then divided, one half carrying beans or clover, and the other half being left as bare fallow. On the other rotation plot the turnips receive superphosphate only, and are carted off the land; the succeeding treatment being the same as that just mentioned. On this last plot the soil is clearly in a far more impoverished condition than on the plot previously described. In Hoos field, wheat and fallow have alternated since 1850, no manure being applied; here also the soil is obviously in an impoverished condition. The figures in the table show that very considerable amounts of nitrates were found in every one of the fallow soils, the quantities being greatest where the land was in the highest condition. In every case the nitrates preponderated near the surface.

The results obtained by the analysis of fallow soils thus amply confirm the conclusions arrived at from a study of the waters from the drain-gauges; it is quite evident that very large amounts of nitrates are produced in soil when exposed to air and rain, and kept free from vegetation,

There can be no doubt that it is in this very considerable production of nitrates that the advantages of a bare fallow consist. If a dry winter follows the summer fallow, the wheat crop, for which the fallow has been preparatory, will find at its disposal an amount of nitrate equivalent to a very considerable dressing of nitrate of sodium, and if the season be favourable, a proportionately heavy crop will result.*

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* A wheat crop of 30 bushels will contain, in corn and straw, about 45 lbs. of nitrogen.

In experiments on alternate wheat and fallow made at Rothamsted, it was found during the first ten years of the experiment that a crop of wheat after fallow was, on an average, nearly double the amount of a crop of wheat following wheat; so that five crops of wheat after fallow were nearly equal to ten crops of wheat after wheat. The wheat after fallow had, indeed, in favourable seasons, two years' production of nitrates to feed upon, while in the case of wheat after wheat, the nitrates at the disposal of the crop were limited to one year's production.

The advantages of a summer fallow are, however, clearly dependent on the character of the following winter. The large amount of nitrates found in the water percolating through the soil of the drain-guages shows only too plainly the loss of fertility which drainage during a wet winter will produce. After a wet winter, the following crop may show little benefit from a previous summer's fallow. But this is not all, for the land, in this case, will have actually suffered in condition from the operation of fallowing. As the nitrogenous organic matter of a soil is being constantly converted into nitrates, the stock of organic matter, which forms the capital of the fertility of a soil, is only maintained by the annual accession of a new crop-residue, consisting of the roots, leaves, and stubble remaining after harvest. In the year of summer fallow there is obviously no crop residue, and if a double crop does not result from the operation of fallowing, the nett result must be a diminution in the nitrogenous wealth of the soil. In the experiments on alternate wheat and fallow at Rothamsted, the benefit from the fallow has gradually diminished, and the soil now contains a lower per-centage of nitrogen than the soil cultivated continuously with wheat. The nett result of the fallow has thus been to lower the condition of the soil.

The quantity of nitrates present in a soil is much increased when the soil has received nitrogenous manure. In Broadbalk field at Rothamsted, devoted to the continuous growth of wheat, every plot is provided with a drain-pipe, lying about two feet below the surface; opportunity is thus afforded for observing the effect of the manures applied on the composition of the drainage-water.*

When ammonium salts (mixed sulphate and chloride) are applied to the land, the first effect produced is the appearance of large quantities of chloride and sulphate of calcium in the drainage-water. The ammonia is at first retained as such by the soil; but nitrification speedily takes place. A distinct rise in the proportion of nitrates in the drainage-water has been observed in one case forty hours only after the application of the manure. If the weather is wet, the nitrification of the ammonia is apparently completed in a few weeks.

On one plot in Broadbalk field ammonium salts, at the rate of about 88 lbs. of nitrogen per acre, are applied in the autumn, five months before the active growth of the wheat crop commences; we have here an opportunity of observing the loss of the manure by drainage, on land practically without a crop. In one extremely wet winter, it was estimated that in 4½ months, 66 lbs. of nitrogen per acre had been removed by drainage, or, to speak more accurately, washed below the level of the drains; and this estimate was undoubtedly below the truth, a considerable amount of chlorides and nitrates having passed downwards by diffusion, over and above the quantity accounted for in the drainage-water. Nitrate of sodium is still more susceptible of loss than ammonium salts; removal by drainage can, in this case, commence immediately after its application, no preliminary process of nitrification being required.

Organic nitrogenous manures, in the form of rape-cake, and farmyard manure, are applied, in the autumn, to two plots in Broadbalk field; it has not been possible, however, in these cases, to form a satisfactory estimate of the losses by drainage, as the drain-pipes from these plots run but seldom. The rape-cake yields a good deal more nitrate than the farmyard manure, but much less than the ammonium salts applied at the same time, and containing nearly the same amount of nitrogen.

Having thus noticed the very considerable production of nitrates in soils, both with and without manure, and the ease with which these nitrates are lost by drainage, we must next consider the part played by a crop.

The growth of any crop on the land will considerably diminish the loss of nitrates by drainage; first, because far more water is evaporated from land covered with a crop than will be evaporated from a bare soil, and the proportion of the rainfall evaporated being increased, the proportion appearing as drainage will be diminished; second, because the crop will take up through its roots the nitrates contained in the soil, and convert this nitrogen into organic matter.

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* Full details respecting the drainage-waters from this field will be found in the next number of the *Royal Agricultural Society's Journal*.

The effect of a crop in diminishing the amount of nitrates in a soil is well illustrated by the analyses of the comparative cropped and fallowed land already given in Table III. It will be seen that on the rotation plot where the land was in the highest condition, the nitrogen as nitrates amounted to only 20·5 lbs. per acre where beans had been grown, while in the uncropped portion of the same plot the amount was 48·8 lbs. On the other rotation plot, with land in much poorer condition, the soil that had carried beans contained 10·6 lbs., and the uncropped soil 36·3 lbs. of nitrogen as nitrates per acre. The effect of the wheat crop in Hoos field is still more striking: here the soil cropped with wheat contained only 2·6 lbs. of nitrogen as nitrates, while on the adjoining fallow soil 33·7 lbs. were found at the same depth. It would appear from these figures that beans, with their small amount of surface root, are less effective than wheat in removing nitrates from the upper layers of the soil; at a greater depth the reverse may possibly be the case.

The power of a wheat crop, when in active growth, to assimilate all nitrates within its reach, is strikingly shown by the composition of some of the drainage waters obtained from Broadbalk field. The waters collected from this field in June and July contain either no nitrates, or an extremely small quantity, in the case of all plots receiving no more than a moderate amount of nitrogenous manure with the necessary ash constituents.

Mr. Lawes has already called attention to the fact that the effect of different crops in checking the loss of soil nitrogen by drainage is by no means alike, and greatly depends on the respective seasons of the year during which they occupy the land. The active growth of cereal crops is confined to three months, April, May, and June; after the time of blooming little or no nitrogen is taken up. A considerable amount of nitrates may thus be produced in the soil during the latter part of summer, and in autumn; and great losses by drainage may take place in autumn and in winter, without any hindrance from a course of cereal cropping, With cereal cropping there is thus always a considerable risk of a serious loss of soil nitrogen.

Messrs. Lawes and Gilbert estimate that 10 or 12 lbs. of nitrogen per acre have been annually lost by drainage on plots in the wheat field receiving no nitrogenous manure; almost the whole of this loss occurring in autumn and winter when there was no crop on the land. The experiments in Broadbalk field also show that when ammonium salts are employed as a manure for wheat, it is only rarely that any distinct effect is produced on the crop in the second year after their application, even when an excessive amount of ammonia has been employed, the nitrogen being apparently lost before the next growing season arrives. This considerable waste of nitrogen during cereal cropping necessitates a continual use of nitrogenous manure to maintain the condition of the land.

In the case of root crops, the growing period extends from July to October or November; the whole of the summer production of nitrates is thus at the service of the crop, and drainage is diminished by plant-growth during the very time of year when the most serious losses might occur. A much greater part of the annually liberated soil nitrogen is thus stored up in a root crop than in the case of wheat, barley, or oats; and a root crop, if consumed on the farm, would tend far more than a cereal crop to conserve the nitrogen of the soil.

The waste of soil nitrogen is prevented still more effectually by permanent pasture. Here we have a crop on the land all the year round; drainage is, therefore, reduced to a minimum, while the nitrates are converted into plant substance almost as soon as they are produced.

The economy of the nitrates naturally produced in the soil, or derived from manure, is a most important subject, and well worthy the attentive consideration of farmers. On these nitrates depends in great measure the fertility of the soil. They represent a very considerable money value, and if lost by drainage can only be replaced by the purchase of expensive manures.* The loss of nitrates on a farm is clearly dependent—1. On the character of the seasons, and especially on the amount of rain that occurs in the autumn and winter. 2. On the character of the cropping, by which the land is left more or less protected at critical times of the year. 3. On the amount and character of the manure, and the time of its application.

To the extremely wet seasons lately experienced a considerable part of the present agricultural depression is certainly due. The produce of the land is governed not only by the character of the weather during a few summer months, but by the character of the preceding autumn and winter. If the nitrates have been thoroughly washed out of the land in the winter, a full crop of corn cannot be expected in the following summer, however favourable the season may then be; the plant food has been extracted from the soil, and the crop must suffer in consequence. The disaster will be least felt on good deep soils; here the nitrates may be washed to a considerable depth without being finally lost. Should a fine spring and summer follow, the nitrates will be drawn upwards as the surface soil dries; the roots of the crop will also, under these circumstances, descend a considerable distance, and feed on the nitrates contained in the subsoil. If, however, the summer season is wet, considerable root development will not take place, and the disaster becomes overwhelming, as in the wet summer of 1879, following a winter of excessive rainfall. In the case of shallow soils of open texture and free drainage, there is but little amelioration to be hoped from a change to favourable weather; nitrates once gone, are here gone for ever, as they rapidly pass to the springs and rivers of the district.

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* At the present price of nitrate of sodium (£16 per ton), the money value of 7 lbs. of nitrogen is very nearly 1s.

Much may be done to meet the difficulties just indicated by suiting the character of the cropping to the climate. Experience has long taught that permanent pasture is the most economical style of farming in a wet climate, while profitable corn growing is only possible with dry seasons; we have indicated some of the causes of this difference between pasture and cereal crops, and have shown that root crops are intermediate in character between corn and pasture as protectors of soil nitrogen. The practical difficulty in the farmer's way lies in the rapid and unforeseen changes of climate to which he is subject. If our Meteorological Office could only forecast the wet or dry character of the weather for a few months ahead, agricultural science could teach the proper course to be adopted on the farm. As, however, there is no hope of such assistance from meteorology, the only thing left to the farmer is to proceed with caution, and to guard himself carefully against the extremest forms of loss.

Where bare fallow is a necessity, it would seem desirable to get the land clean as soon as possible, and to sow mustard or some other rapidly-growing green crop in July or August, the crop to be ploughed in before wheat sowing in November. The mustard, during its growth, would take up a great part of the nitrates present in the soil, and this nitrogen would be returned to the land in the form of insoluble organic matter; it would now be little affected by winter drainage, but would afford food to the wheat in the following spring.

Mr. Lawes has recently recommended that foul, neglected land, instead of being cleaned by repeated bare fallow, should be pastured by sheep supplied with cake, and finally sown with grass seeds. A continuance of such treatment will destroy the weeds, without exhausting the land by the double process of the removal of a large crop of weeds, and repeated treatment as bare fallow.

Where wheat is to be followed by turnips, or by another corn crop, it is clearly desirable that the land should be occupied by some green crop during the autumn and winter. Rape sown soon after harvest, and fed off before ploughing in the following spring, would, from our present point of view, be a practice extremely advisable. Unfortunately, however, ploughing in autumn is, in many cases, a necessity, if ploughing is to be done at all; and the benefits of autumn ploughing on heavy land are so considerable, that the losses by winter drainage must be very great to warrant its abandonment.

It is further clearly of advantage in wet climates to allow the arable land to remain more than one year in seeds; the conditions are then, of course, very similar to those of permanent pasture, and very favourable to the protection of soil nitrogen. This plan is already in constant use in the north of Europe. The special advantage of deep-rooted crops, capable of taking up nitrates that have passed into the subsoil, is also obvious.

With regard to manures, it is clear that where the rainfall is excessive preference must be given to organic forms of nitrogenous manure, which, though slow in action, are comparatively little liable to suffer loss by drainage; and this will be especially necessary in the case of light and shallow soils. Nitrate of sodium, or manures like guano rapidly converted into nitrates, can generally only be economically used as spring dressings, applied when the crop is in a condition to make immediate use of them. During the last three years, the loss of nitrates by drainage from the spring dressings of ammonium salts at Rothamsted has been, on an average, less than half as great as that from the autumn dressings. When, however, the winter is dry, it is of advantage to manure wheat with guano or ammonium salts in the autumn; the Rothamsted experiments showing that in such a season a larger crop will be obtained by autumn than by spring sowing; this is true at least on heavy land. If the nitrates in the soil are to be taken up to the greatest extent by the crop, it is also necessary that the soil be not deficient in any of the ash constituents which the crop requires; any deficiency of ash constituents limits the growth of the crop, and thus its power of appropriating nitrates. This fact is often forgotten by farmers. The poor results sometimes obtained from the use of nitrates of sodium are often due to the fact that the manure has been applied alone without the addition of superphosphate.

It is evident that much must be left to the judgment of the farmer: he will have to consider in each case—Is it cheaper to buy nitrates, or to take more or less expensive measures for their preservation? The success of his endeavours will after all greatly depend on the vicissitudes of the seasons. It may be hoped, however, that something has been done by showing, from actual field experiments, what are the conditions under which nitrates are lost, and what are the conditions most suitable for their preservation.

DISCUSSION.

Mr. **Darby** said the reader of the paper had spoken of the very important investigation of drainage water at two feet deep, but it struck him that it would have been far better if the investigation had been taken at three feet deep. Most farmers preferred to lay their drains a little deeper than two feet; it depended, of course, on the soil, but as a rule practical farmers preferred a depth of about three feet. He was convinced, from practical observation and reading, that water generally came in after heavy rains pretty pure from drains of three feet deep, particularly if there was a clay subsoil. He had seen cottagers going with their pitchers to take water from drain pipes in preference to using that from their own pumps, both for drinking as well as washing. He had seen it stated that the water was very pure after having percolated through clay soils. Some years ago, Professor Way, who took great interest in these matters, showed that the silicates not only attracted the ammonia, but retained it with a pretty tight grasp. He fancied that some of these investigations must have been carried on on very porous soils, which allowed the nitrates to escape in the drainage; or that this matter, which had been compared to yeast, which caused the nitrification, must be very much more effective on some soils than on others; that it had not the strong action which was represented in the paper on all soils, and perhaps not on the majority. He fancied there was something in the Rothamsted soil which assisted the matter.

Mr. **Baldwin Latham** said he was extremely interested in this subject, and the paper seemed likely to throw some light on the important question of the purification of sewage. He had recently been carrying out a series of works by means of artificial filters for the purification of sewage. Having met with a dense clay soil at Merton, it became necessary to dig it all out and construct an artificial filter. He did this by burning the clay into ballast, and then took a layer of six inches of surface earth, and an alternate layer of burnt ballast. and in this way made a filter bed five feet deep. The result, with regard to purification, was most surprising. They were now dealing with the sewage of about 14,000 or 15,000 people, and it was most perfectly purified on an acre of ground. Thus ten acres would suffice for the purification of the sewage for the whole year. By using this particular class of filter, which appeared to be in accordance with the advice of Mr. Warington, namely, that you have in the surface material the medium for the development of nitrification, and in the burnt ballast the porous material by which air could be readily supplied to the alternate layers of more oxidising material, you would be able, where the area of land was limited, to deal with great volumes of sewage without difficulty. His object in attending that evening was to learn whether this question of nitrification was likely to throw any light on the sanitary question, and on the condition of water as connected with the propagation of disease. There was no doubt of this fact, that the period of percolation in this country was the period of zymotic disease. The moment water began to percolate through the soil then typhoid fever and scarlet fever became rife; and just in the proportion as the water began to diminish, this disease began to fall off. They found also this fact, that the dry years, or rather the periods immediately succeeding dry years, were the periods when there was the greatest intensity of disease. The period of dryness was the measure of the intensity of disease which would follow the moment percolation took place, and thus, after a long dry period, there came the most unhealthy periods. Statistics now went back for over 40 years, and he had been able to collect figures with regard to underground water, from which it appeared indisputable that the periods he had referred to were those when disease was most rife. Even the health of London itself was absolutely proportional to the quantity of water coming down the Thames; when a large quantity was coming down, the health of London was good, and during very wet periods, such as during the last five years, the health of the country has been peculiarly good. He hoped the investigation of Mr. Warington would throw some light on the question whether these particular forms of life which produced nitrification were not themselves the cause of disease, and whether it was not possible for the human subject to take in these particular forms of life, or kindred forms which existed under the same conditions, when these were washed out of the soil into the water supplies. Hull had been suffering from a virulent epidemic of scarlet fever for six months past, and the disease was still abnormally high in that district, and it was a most significant fact that this epidemic was preceded last autumn by one of the lowest levels of water in the chalk which had ever been known there, so much so, that the engineers reported that if the water continued to decline, in a few days people must be put on a short supply of water in Hull. The very moment percolation commenced in that district, this virulent epidemic occurred, and as the percolation was now diminishing, the disease seemed to be declining. There was no doubt in his mind that the propagation of diseases followed general laws, if they could only discover them. They generally found that those periods which were so advantageous to the agriculturist were detrimental to the public health, and, therefore, he thought it would be very useful if attention were paid to this question by the gentlemen connected with the Rothamsted Laboratory. The agriculturists of the country were much indebted to Mr. Lawes for the great trouble he had taken to enlighten them, and it was gratifying to know that whenever any new point came up it received attention and elucidation in that laboratory. With regard to the analysis of water supply, as far as he was concerned, he did not think that analysis would ever throw light on the wholesomeness or the reverse of water. Only lately, in a village in Warwickshire, he had seen people prefer to take their water supply from surface drains, instead of from their pump, but he thought that might be accounted for; shallow drainage water being thoroughly nitrified would be rendered wholesome, whilst the deeper water of the wells and pumps close to the cottages were in contiguity to cesspools, and as deep soil did not produce nitrification, it was very likely that the people, by long use, had found that the superficial water was wholesome, whilst the deeper water from the wells was not so.

Mr. **Clements** said this was a very important question, and many attempts had been made to utilise the sewage which was thrown away, but unfortunately it had been found that the expense of doing so was greater than the buying of artificial manures. Sometime ago he had seen the sewage filters of Croydon, which were absolutely free from any offensive smell, and if the method of filtration by gravitation could be generally adopted, no doubt it would be economical; but in many cases that could not be done. The main purport of the paper seemed to be to draw attention to the importance of devising some means by which the waste of nitrates could be prevented; but he understood that some time ago Professor Way performed a number of experiments which tended to show that nearly all the nitrates, and especially ammonia, were preserved in the soil.

Mr. **Bernard Dyer** said, as a chemist, he should like to somewhat qualify the remark which had fallen from Mr. Latham. He thought all chemists would be ready to admit that water analysis did not necessarily show whether water was wholesome or unwholesome, but it would, in a great many cases, reveal the presence of sewage in water, and of sewage in an unoxidised condition; and in such a case, it was fair to assume that such water was and must be unwholesome. He could not detect the germs which carried disease, but still their presence might be often inferentially assumed. It was not well that water analysis should appear to be condemned, because it could not pronounce decisively whether water was wholesome or unwholesome.

Sir **Thomas D. Acland** said he took a very deep interest in the work going on at Rothamsted, under Mr. Lawes, Dr. Gilbert, and Mr. Warington, and as he appeared to be the only member of the Council of the Royal Agricultural Society present, or of the Bath and West of England Society, he might presume, as a country gentleman, to express, on their behalf as well as his own, his great sense of obligation to Mr. Warington for his paper, and to Dr. Gilbert, for taking the chair. He had just come from another place, where they were endeavouring to reform the mothod of procedure, by restraining vain and self-asserting people from wasting public time. In the present case, the difficulty seemed to be to induce modest people, who knew something of the subject, to state what they knew. When he was editor of the *Bath and West of England Journal*, his difficulty was of the same kind; those who knew a great deal would not write, and some who did write, were not, perhaps, exactly in the first class. They all had a great deal to learn, and he might say, that the whole of Europe felt the enormous debt it owed to Rothamsted. He rather expected that his friend Mr. Darby would have started a fresh hare, in the shape of the question how much nitrogen certain plants absorbed directly from the atmosphere, but as he had not, perhaps it was as well not to say anything about it. He came there, as representing the distressed agriculturists, to learn, if he could, how they were to get this food for plants which they were all so anxious to get; and he might also say, on behalf of farmers and landowners, that every one who could throw any light on the question of the source of nitrogen, the means of getting it, and the prevention of waste of this valuable material, would be rendering a great service, not to one class only, but to the whole nation. One subject which he had hoped to hear touched upon, had not been alluded to, and that was the question of water meadows, of which, as a Devonshire man, he knew something. He did not think scientific men had yet told them what was the explanation of the wonderful effect of hill country waters on meadow land.

Colonel **Jones** said he was always very grateful for the assistance of Rothamsted, and he had on a former occasion obtained a good deal of aid from Mr.

Warington with regard to the treatment of town sewage on land. Since reading his first paper on nitrification, he had been satisfied that they were on the right track, but he had hoped that something might have been done by the microscope to discover these living organisms which were so effective in the work of nitrification. That had been referred to in Mr. Warington's first paper, and he wished a little more information about it had been given on the present occasion. It was unfortunate that they had not any drain gauges near the surface of the soil, for he had always noticed that in the growth of crops the nitrogen seemed to be taken up in the first few inches of the soil; whilst the sewage might pass through the subsoil with hardly any purification at all. There was nothing, in fact, to equal the matted roots of rye grass on the very surface as a purifying agent. He should have liked to have heard some reference to the great waste of nitrogen which went on every day in the coke ovens throughout the country. In the manufacture of gas coke, the nitrogen was made use of, and converted into sulphate of ammonia, but in ordinary coke ovens it was all suffered to run to waste.

The CHAIRMAN thought everyone would agree that Mr. Warington had amply fulfilled his promise to bring forward the practical aspects of recent experiments in connection with nitrification. Some parts of the subject he had treated with more and others with less detail. With regard to the bearings on ordinary practical agriculture, on which he had given some tables, he might say that in connection with that subject, there were no less than 1,300 determinations of nitric acid in drainage waters, made at Rothamsted, the results of which would soon be brought out by Mr. Lawes, Mr. Warington, and himself. The great importance of nitrification in connection with the sewage question had been referred to by several speakers. In 1855, Mr. Lawes read a paper in that room, on the sewage of London, and to show the advance in knowledge since that time, he might mention that though that paper was a very exhaustive one with regard to all aspects of the question which were then considered, there was no reference in it whatever to the nitric acid in the drainage water; nor was there in the more recent official examination of the subject by Hofmann and Witt, although their report was to a great extent a chemical one; neither was there in some further researches, by Mr. Way, although just about the same time—in 1856—he found nitric acid in drainage water from ordinary agricultural land, and in large quantity. Still, the subject did not strike agriculturists as being of very great importance. Soon after, a Royal Commission on Sewage was appointed, upon which, with others, were Mr. Lawes and Mr. Way, who formed a subcommittee to institute experiments on the utilisation of sewage. He had himself the superintendence of those experiments to a great extent, and during the course of the inquiry they had 93 samples of sewage, and 62 samples of drainage water analysed; but it was not until they came to write their report, and to make up the nitrogen account, so to speak, that they really felt there must be more nitrogen in the drainage water than was determinable in the ordinary way as ammonia; and accordingly, although the report was partly drafted, another experiment in another field was set on foot, with the view of collecting samples, to see if there were not nitric acid. They then found there was a great deal more nitrogen as nitric acid in the drainage waters than there was as ammonia, or in any other form. Not only did it show a little farther where the nitrogen had gone, but it was an indication, so far, of purification, because to the extent that nitrification had taken place, so far there was an indication of purification. From that time to the present, every important sewage inquiry had involved an immense number of determinations of nitric acid. The Rivers Pollution Commissions, first under Mr. Way, and then the more elaborate investigations conducted under Dr. Frankland, the very extensive series of sewage inquiries conducted by the British Association Committee, and a great many independent investigations in different districts by Dr. Voelcker, had all shown that an enormous quantity of nitric acid was found in drainage from sewage. Mr. Warington had referred to Dr. Frankland's plan of intermittent filtration, which he devised after a number of laboratory percolation experiments. Dr. Frankland had investigated the waters, after such filtration at Merthyr Tydfil, but he did not remember the results. The British Association Sewage Committee also undertook the examination of those waters, and so far as they could calculate, the whole of the nitrogen in solution was converted into nitric acid. The public must lay their account with the fact that it was utterly hopeless, having got excrementitious matters into a large quantity of water which went through a town, ever perfectly to utilise the constituents of the sewage; but they could to a very great extent purify it, and it would be found that the amount of nitric acid was the indicator of the purification within certain limits. The reduction in the amount of organic nitrogen, the reduction in the amount of ammonia, and the increase in the amount of nitric acid, were points to be aimed at, and according to the local circumstances, and the area of land available, so they must endeavour to leave as little organic nitrogen and ammonia in the drainage water, and to get as much nitric acid formed as possible. Of course a large quantity of nitric acid in drainage water was an indication of great waste, but towns must be extremely well satisfied if they got their sewage waters so far purified, if they could go into a water supply, and do but little damage, or be useful. Of course, it depended on the amount of dilution which the drainage water received when it got into the stream, how far it was absolutely necessary that the whole of the nitrogen in the sewage should be oxidised or not; but it was the first thing towns must see to, the oxidation of the nitrogenous matters, and beyond that they might endeavour to utilise it, if the extent of the land available and local circumstances were favourable. His belief was that a great deal more might be done than was at present supposed possible, if it were taken up by towns themselves, instead of it being supposed that the sewage must be sold out to farmers, to mix it up with their ordinary agriculture. To mix up sewage with ordinary agriculture meant an extension of area, and that meant a great cost of distribution, and although you had a greater utilisation, you might pay too dear for gold. The thing was, so to strike a compromise between wasted material and expenditure in distribution, as to unite nearly perfect purification with utilisation as far as possible. Mr. Darby had objected to the depth of the drain-pipes, but it should be stated that the depth was two feet below the furrow, and the pipes were presumed to be laid two feet six inches from the general level of the field. Of course, the depth varied slightly, but he should say it was much nearer two feet six inches than two feet. As to the statement that at three feet you got extremely pure water, he had no doubt that exceedingly sparkling water was got; drainage waters were often excessively bright and clear, but they might contain a large amount of nitric acid, which was a proof that you had got rid of organic nitrogen, and probably most of the ammonia, but that you would have large quantities of nitric acid was absolutely certain. Mr. Darby, and also Colonel Jones, referred to Professor Way's experiments on the absorption of ammonia by soils, and there was no doubt the soil did take up ammonia; but there was no doubt also that these organisms soon destroyed it, and there was not the accumulation generally supposed. The experimental wheat-field at Rothamsted was about 39 years old; and they had determined the nitrogen in different plots at different periods. Such accumulation as there was could not be attributed to the direct retention of the ammonia of the manure, but was mainly, if not entirely, attributable to the residue of the crop. For instance, where they put no nitrogen at all, there was a considerable reduction from year to year, and by continuing the experiments for a long time, these points were clearly determined. They had the clearest evidence that where they had not applied nitrogen, notwithstanding the residue of the crop, there was a gradual reduction; where they had applied nitrogen, especially where it was mixed with sufficient mineral matters, they had much more than where they had applied none. But so far as they could make a reckoning backwards, they assumed they had only got just about as much as would have brought it up to its original condition; and when they took the relation of the carbon to the nitrogen in the soil on the different plots, they came to the conclusion that almost all the nitrogen not washed away was in the residue of the crop, and not as ammonia of the manures. So far as manures were applied in the condition of slowly decomposable organic matter, or in dung, there was more tendency to accumulation, but in the case of ammonia there was practically no retention even by their rather heavy soil. That reminded him that Mr. Darby had referred to the Rothamsted soil as something peculiar, which he could not agree to. In a discussion they had with Baron Liebig, he at one time said it was very poor, and at another time that it was very rich, at any rate it was not fit for experimenting. But as far as they knew, it did not give fallacious results, and it certainly was not a soil of great permeability. It was a rather heavy loam, with a pretty impervious stiff clay below. With regard to Mr. Latham's observations, he quite agreed with him that this subject did throw a light on the question of the purification of sewage. So far as the question of the nitrifying organism was concerned, the microscope had not been neglected; it had been used by Mr. Warington himself, and also by Prof. Lankester, and it was found extremely difficult to identify these things. He might here refer to a point that Mr. Warington had not had time to refer to. That in the course of his cultivation of these nitrifying bodies, he had found — whether it was another organism, or a modification of the nitrifier, was uncertain—but he did get an organism which simply carried the ammonia to nitrous acid, and not to nitric acid. This result was very interesting, in connection with the results of Pasteur, who had long been working on the degradation of organisms, which were of vast importance to agriculture, so as to reduce the virulence of certain diseases. He had the pleasure of being in his laboratory in the autumn, where he saw hundreds of little flasks in preparation, and he understood him to say that there he had enough material for one-sixth of all the sheep in France. That was against anthrax or charbon, a disease which did occur here, but not to so great an extent as in France, and which Pasteur had traced to an organism which he could cultivate and degrade, until the disease was so reduced as to be of comparatively little importance.

Mr. Warington said, in reply, he might supplement the remark of Dr. Gilbert, with regard to the drain-pipes, by reminding Mr. Darby that the experiments were very old, and in consequence many of the arrangements were made at a time when they did not know quite as much as they did now. He was sure Mr. Lawes would say that the drain-pipes were laid too near the surface; but they were laid in 1849, and as Mr. Smith's (of Deanston) system had only just been published, it was not unnatural that they were laid on his system. He had been extremely interested with Mr. Latham's remarks as to the wonderful efficacy of the surface soil as a nitrifying bed, and he hoped his experience would encourage others to work in the same direction, and to see whether nitrifying filters might not be made occupying a far smaller area than had been supposed necessary for a given population. With regard to the nitrifying organism, he knew of no experiments to show that it was itself injurious to health, or that it would produce any ill effect if an animal were inoculated with it. There was no doubt the soil was full of organisms, but he fancied any medical man who had studied the subject would say that every disease had its own special organism, and that it was not every organism which would produce disease. The soil must receive sewage from diseased persons; this would accumulate on the surface in dry weather, and when wet weather came the organisms would be washed out into the drainage water, and so, into the drinking supply. With regard to the question as to how it was water should be so effective in irrigated meadows, it had always been a subject of difficulty, because very little had been done in the way of experiment. They wanted to gauge the water that went on to the land and analyse it, and also to analyse that which came off; if the water which went on contained nitrates, they could readily understand that the grass would be much better for it. It came then in fact to a very weak sewage irrigation. On the other hand, some persons said that part of the results were merely mechanical, and that the active growth they got in the early spring months on water meadows was, in some respects, due to the temperature which the water gave. Now that they understood more about the mechanical theory of heat, they knew that moving water always developed heat; and he believed people who owned water meadows would say that it was only moving water which had any effect—that stagnant water would be quite inefficacious. There was a great deal to be done in microscopic investigation, and he hoped they would be able to say a little on the subject before long, but at present their results were not sufficiently advanced. With regard to the great loss of nitrogen from coke ovens, it was simply a question whether it would pay for the expense to put up apparatus to save it, and he should think that people who did the coking would probably be the best judges on a question of that kind.

The CHAIRMAN then moved a vote of thanks to Mr. Warington, which was carried unanimously.

Sir THOMAS ACLAND said the intention of the Government was being much called to education in agriculture, and he hoped the Society would not allow all that work to be taken out of its hands, but that some efforts would be made to bring agriculturists into communication with scientific men, so as to throw light on their work in the way Mr. Warington and Dr. Gilbert had done.

RAILWAY EXHIBITION AT VIENNA.—An International Exhibition of railway plant is projected at Vienna, to be held on the Prater, in 1884, under the auspices of the Minister of Commerce. The organising committee includes the names of Herr von Banhaus, formerly minister, Herr Prenninger, and Herr Obermayr.

Miscellaneous.

SILK-PRODUCING AND OTHER BOMBYCES REARED IN 1881.

By ALFRED WAILLY.

(Membre-Lauréat de la Société d'Acclimatation de France.

PART III.

Samia Gloveri.—Three North American silk-producing bombyces, very closely allied, have been mentioned in my previous reports; they are: *Samia Ceanothi*, from California; *Samia Gloveri*, from Utah and Arizona; and *Samia Cecropia*, commonly found in most of the Northern States—the latter is the best and largest silk-producer. Crossings of these species took place in 1880, and, as I stated before, the ova obtained from a long pairing between a *Ceanothi* female with a *Gloveri* male, were the only ones which were fertile. The *Gloveri* cocoons received in 1880 were of a very inferior quality, and produced moths from which no pairings could be obtained; although some crossings took place. In 1881, the *Gloveri* cocoons, on the contrary, produced fine, healthy moths; yet only five pairings could be obtained, with about 100 cocoons. Besides these five pairings, a quantity of fertile ova were obtained by the crossings of *S. Gloveri* (female) with *S. Cecropia* (male), and *Cecropia* (female), with *Gloveri* (male). No success, so far as I know, was obtained, with the rearing of the hybrid larvæ; the rearings of the larvæ of pure *Gloveri* were also, I think, a failure, only one correspondent having been successful; but some correspondents have not yet made the result of their experiments known to me. The larvæ of *Samia Cecropia*, *S. Gloveri*, and *S. Ceanothi*, are very much alike; and hardly any difference can be observed in the first two stages. In the third and fourth stages, the larvæ of *S. Cecropia* and *S. Glover* are also nearly alike; the principal difference between these two species and *S. Cecropia* being that the tubercles on the back are of a uniform colour—orange-red, or yellow—while on *Cecropia* the first four dorsal tubercles are red, and the rest yellow. The tubercles on the sides are blue on the three species.

The larvæ of the hybrids *Gloveri-Cecropia* were, as far as I could observe, like those of *Cecropia*, but I noticed some with six red tubercles on the back instead of four, as on *Cecropia*. They were reared on plum, apple, and *Salix Caprea*, in the open air.

The larvæ of *Samia Gloveri* were reared during the first four stages, on a wild plum tree, then on *Salix Caprea*, and I reproduce the notes taken on this species, which I bred this year (1881) for the first time.

Gloveri moths emerged from the 15th of May to the end of June; five pairings took place as follows:—1st, 4th, 9th, 24th, and 26th of June. First stage—

larvæ quite black. Second stage—larvæ orange, with black spines. Third stage—dorsal spines, orange-red, spines on sides blue. Fourth stage—dorsal spines, orange or yellow, spines on the sides blue; body light blue on the back, and greenish-yellow on the sides; head, green; legs, yellow. Fifth and sixth stage—larvæ nearly the same; tubercles on the back yellow, the first four having a black ring at the base; side tubercles ivory-white, with a dark blue base.

The above-mentioned American species, like most other silk-producing Bombyces, were bred in the open air, but besides these, I reared three other species of American Bombyces in the house, under glass, and with the greatest success. These are:—*Hyperchiria io*, a beautiful species mentioned in my report for the year 1879; *Orgyia leucostigma*, from ova received on December 29th, 1880, from Madison, Wisconsin, which hatched on the 27th of May, 1881.

The third American species reared under glass is the following very interesting Bombyx:—*Ceratocampa (Eacles) imperialis*. The pupæ of this species are rough, and armed with small, sharp points at all the segments; the last segment having a thick, straight, and bifid tail. The moths, which measure from four to about six inches in expanse of wings, are bright yellow, with large patches and round spots of redding-brown with a purple gloss; besides these patches and round spots, the wings are covered with small dark dots. The male moth is much more blotched than the female, and, although of a smaller size, is much more showy than the female.

With 24 pupæ of *Imperialis* I obtained 19 moths from the 21st of June to the 19th of July; five pupæ died. Two pairings took place, the first from the evening of the 13th to the morning of the 14th; the second from the evening of the 15th to the morning of the 16th of July.

The ova, which are about the size of those of *Yama-mai*, *Pernyi* or *Mylitta*, are rather flat and concave on one side, of an amber yellow colour and transparent, like those of sphingidæ. When the larvæ have absorbed the yellow liquid in the egg, and are fully developed, they can be seen through the shell of the egg, which is white or colourless when the larva has come out.

The larvæ of *Imperialis*, which have six stages, commenced to hatch on the 31st of July, the second stage commenced on the 7th of August, the third, on the 17th; the fourth, on the 29th of August; the fifth, on the 18th of September, and the sixth, on the 1st of October. The larvæ commenced to pupate on 13th of October.

The larvæ of this curious species vary considerably in colour. Some are of a yellowish colour, others are brown and tawny, others are black or nearly black. My correspondent in Georgia, who bred this species the same season as I did, in 1881, had some of the larvæ that were green. In all the stages the larvæ have five conspicuous spines or horns; two on the third segment, two on the fourth, and one on the last segment but one; this is taking the head as the first segment with regard to the first four spines. These spines are rough and covered with sharp points all round, and their extremities are fork-like. In the first three stages they are horny; in the last three stages these spines are fleshy, and much shorter in proportion than they are in the first three stages. The colour of the spines in the last three stages is coral-red, yellowish or black. In the fifth and sixth stages the spine on the last segment but one is very short.

Here are a few and short notes from my book:—

1st stage. Larvæ, about one-third of an inch; head brown, shiny, and globulous.

2nd stage. Larvæ, dark-brown, almost black; spines, white at the base, and black at the extremities; head shiny and light brown.

3rd stage. Larvæ, fine black; head black; white hairs on the back; spines, whitish, buff, or yellowish at the base, and black at the extremities; other larvæ, of a brown colour.

4th stage. Larvæ, black granulated with white; long white hairs; horns, brown-orange with white tips; on each segment two brown spots. Spiracles well marked with outer circle brown, then black, white and black dot in the centre. Anal segment with brown ribs, the intervals black with white dots; head shining, black with two brown bands on the face, forming a triangle. Other larvæ in fourth stage, velvety black, with coral-red spines; others with black spines.

5th stage. Larvæ, entirely black with showy eye-like spiracles, polished black head; other larvæ having the head brown and black. Larvæ covered with long white hair; spines black or red. No difference noticed between the 5th and 6th stages.

One larva on 4th stage was different from all others, and was described at the British Museum by Mr. W. F. Kirby, as follows:—"Larva reddish-brown, sparingly clothed with long slender white hairs, with four reddish stripes on the face, two rows of red spots on the back, spiracles surrounded with yellow, black and red rings, legs red, prolegs black, spotted with red. On segments three and four are four long coral-red fleshy branched spines, two on each segment, below which, on each side, are two rudimentary ones just behind the head; in front of segment two are four similar rudimentary orange spines or tubercles; last segment black, strongly granulated and edges triangularly above and at the sides with coral-red; several short rudimentary fleshy spines rising from the red portion; the last segment but one is reddish above with a short red spine in the middle, and the one before it has a long coral-red spine in the middle similar to those of segments three and four, but shorter."

As soon as my *Imperialis* larvæ had hatched, I gave them various kinds of foliage, plane-tree, oak, pine, sallow, &c. At first they did not touch any kind of foliage, or they did not seem to touch any; and I was afraid I should be unable to rear them; but on the second or third day of their existence, they made up their minds and decided upon eating the foliage of some of the European trees I had offered them. They attacked oak, sallow, and pine, but did not touch the plane-tree leaves. In America, the larvæ of *Imperialis* feed on button-wood, which is the American plane tree *(Platanus occidentalis)*, yet they did not take to *Platanus orientalis*. After a little time I reduced the foliage to oak and sallow branches, and ultimately gave them the sallow *(Salix Caprea)* only, on which they thrived very well. I was pleased with this success, as I had previously read in a volume of the "Naturalist's Library" a description of *Ceratocampa imperialis*, which ends as follows:—"The caterpillars are not common, and are the most difficult to bring to perfection in confinement, as they will not eat in that situation; and, even if they change into a chrysalis, they die afterwards."

Before I finish with *C. Imperialis*, I must mention a peculiar fact. During the first stage, and, I think, also during the second, several larvæ disappeared without leaving any traces. I also saw two smaller larvæ held tight by the hind claspers of two larger ones. The larvæ thus held and pressed were perfectly dead when I observed them, and I removed them. My impression then was that these larvæ were carnivorous, not from this last fact alone, as I had previously observed it with larvæ of *Catocalæ* when they are too crowded, but from the fact that some had disappeared entirely from the glass under which they were confined. I began to reduce their numbers, and put six only under each glass, so as to be able to watch them better. Whether I had made a mistake or not previously to this I do not exactly know; but from this moment the larvæ behaved in a most exemplary manner, especially when they became larger. They crawled over each other's backs without the least sign of spite or animosity, even when they were in sleep, in which case larvæ are generally very sensitive and irritable, all were of a most pacific nature. It is, therefore, with the greatest pleasure that, for want of sufficient evidence, I withdraw this serious charge of cannibalism which I first intended to bring against them.

From what has been said respecting the rearing of exotic silk-producing Bombyces, especially tropical species, it must have been observed that several difficulties, standing in the way of success, have to be overcome. The moths of North American species emerge regularly enough during the months of May, June, or July, but Indian and other tropical species may emerge at any time of the year, if the weather is mild, as it has been the case during this unusually mild winter of 1881-1882. From the end of December to the present time (March 14th, 1882) moths of four species of Indian silk-producers, especially *Antheræa Roylei* and *Actias Selene*, have constantly emerged, but only one or two at a time. These moths emerged from cocoons received in December and January last.

It is only when these tropical species shall have been already reared in Europe, that the emergence of the moths will be regular; then they will be single-brooded in Northern or Central Europe, and some will very likely become double-brooded in Southern Europe. But when just imported the moths of these tropical species will always be uncertain and irregular in their emergence, hence the importance of having a sufficient number of cocoons so as to meet this difficulty, *i.e.*, the loss of the moths that emerge prematurely or irregularly.

Before I conclude, I shall repeat what I already stated in a previous report, that the sending of live cocoons and pupæ from India and other distant countries to Europe, can easily be done, so that they will arrive alive and in good condition, if care be taken that the boxes containing these live cocoons and pupæ should not be left in the sun or near a fire (which has been the case before), and that they should at once be put in a cool place or in the ice-room of the steamer. The cocoons and pupæ should be sent from October to March or April, according to distance, and it is most important to write on the cases, "Living silkworm cocoons or pupæ, the case to be placed in the ice-room."

By taking this simple precaution, live cocoons and pupæ, when newly formed, can be safely sent from very distant countries to Europe.

To continue these interesting and useful studies, I shall always be glad to buy any number of live cocoons, or exchange them for other species, if preferable.

ALFRED WAILLY.

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APPLICATION OF ELECTRICITY TO THE PREVENTION OF FIRE-DAMP EXPLOSIONS.

M. Léon Somzée consulting gas engineer and *ingénieur honoraire des mines*, Brussels, has published a treatise on the above subject, followed by a description, illustrated by diagrams, of the various appliances which he has devised for carrying out his recommendations. The principal instruments were shown at the Electrical Exhibition of Paris, and have been practically used in some German collieries, having secured the approval of Herr Wenderoth, Privy Councillor for Mines in the Saarbrück district.

M. Somzée observes that there is no mining country of importance that has not paid an ample tribute to that underground scourge, the explosion of fire-damp, and that Yarrow, Hartley, Frameries, and many more names, will never be effaced from the martyrology of mining industry.

Referring to paragraphs 5 and 6 of the conclusions adopted, at the *Congrès d'Hygiène et de Sauvetage*, Brussels, 1876,* by the section dealing with mine explosions, M. Somzée proposes the following modification:—

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* See the *Journal* of the Congress, 13th Oct, 1876, vol. xxiv., p. 983, Sec. ii., div. A. Civil Sauvetage.

"It is advisable to organise, in every mine, a special service charged with supervising and keeping a check upon the ventilation, and directing it if occasion should require. It is indispensable that those set over this service should be constantly, instantaneously, and correctly informed as to the composition of the air in the mine, at different points to be determined by practice, especially where lights are used and blasting is carried on, whatever be the variations of pressure and temperature. It is necessary that precise indications be obtained of even very minute quantities of dangerous gases, for it has been observed in England that a proportion of one, and even one-twentieth per cent. is sufficient to render explosive the mixture of air and gas when there is coal dust in suspension. In such a case, we would go further and advance the opinion that a trace even of fire-damp, is sufficient to bring about an explosion, having, as gas engineer, seen explosions occur in air containing dust of great fineness—explosions which were erroneously attributed to the presence of lighting gas alone. It is desirable that every working place be put into communication with a central point of observation, either underground or on the surface, and be connected with the mechanism of the ventilator; that an alarm, in communication with the fire-damp, give notice of its presence through the engine-man or manager, by means of a mechanical action set up by the gas itself; and that the miners be also supplied with a warning appliance which shall force them to take precautions—or, better still, shall take the precautions independently of their will: to particularise, that the presence of fire-damp in the mine in a state of danger be signalled by bells, not only to the miner, but throughout the colliery and on the surface, in the offices, and to the men tending both the ventilator and the winding engines. Lastly, that measures be taken to regulate the ventilation instantaneously, and also to direct its effect wherever required, through a special ventilating gang, receiving their orders from far or near by means of electromotors."

Short of suppressing the cause which produces fire-damp, one of the most efficacious means for warding off mine accidents consists in preventing the mixture of air and gas from attaining the proportion which renders it explosive. In order to do this, it is necessary to be warned of the presence, or slow invasion, of this dangerous gas in the atmosphere of the mine; that is to say, to have precise indications of slight quantities of fire-damp in the air.

Various attempts have been made in this direction, but without success, on account, either of the imperfect nature of the appliances, or of their not being used properly. The best indication of fire-damp at present known is the safety-lamp; but unfortunately, when the state of the flame makes known the presence of this gas, its proportion is already so high in the air, that the moment is not far distant when it may become explosive, owing to the presence of coal dust. This fact alone would imply the necessity of seeking a practical indicator which shall permit of detecting slight traces of fire-damp in the air of the mine; and sensitiveness in revealing the presence of this gas ought to be the first condition in such an appliance.

This is the problem which M. Somzée set himself to solve; and his studies ultimately resulted in two classes of instruments, one indicating, and the other giving warning of, minute quantities of fire-damp, or of carbonic acid. The first permits of ascertaining the precise quantity, even to the slightest trace, of deleterious or explosive gases entering into the composition of the air, and independently of the variations of the barometer and thermometer. It is based upon the principle of the difference of power possessed by gases of absorbing radiant heat, and is set up at any point in the mine, even in the most remote corners.

As the safety lamp is now generally used in collieries, M. Somzée has utilised it for furnishing the calls and indications necessary for keeping a check upon the ventilation. The modification consists only in the addition of a metal ring or band, expanding by heat and capable of closing an electric circuit for causing bells to ring; while there is nothing to destroy the element of safety. In the portable miners' lamps, a small bell is contained in the case; but the fixed lamps are placed in electrical communication with bells in the office of the ventilation officer. The essential advantage of these warning lamps is, that they reveal the presence of fire-damp before the flame of the safety-lamp — even the "Davy" — makes known the ingress of this gas into the air. The elongation of the flame of the lamp, caused by the presence of fire-damp, is one of the principal properties, the effects of which are turned to account in the construction of the apparatus. It affords certain variations of temperature at a given point in the lamp, where the increased heat, due to the gas, sets up a mechanical action which is practically utilised.

Another warning instrument of great sensitiveness, and working automatically whatever be the pressure and temperature of the atmosphere, is based upon the mechanical power of an osmotic current to give an alarm by bells placed in an electric circuit. It may be placed at different points of the advanced workings, and gives warnings to the ventilation officer of ten per cent. of injurious or dangerous gas at the place of observation, carried along by the air current.

In view of the future use of the electric light in collieries, M. Somzée also proposes, as warning instruments, and as means of preventing the mixture of air and gas from attaining dangerous proportions, electro-chemical appliances, based upon the reactions between different substances under the influence of the electric light, for giving calls from all the stations of observation. These lamps would not be for the general use of the miners, but would rather be stationary, or used only by inspectors and foremen.

A last class of warning instruments consists in transforming the safety lamp into a "singing lamp," by the excitation of a sonorous tube placed over the flame. One tube only may be used; or two or more, may give out different notes, and come into operation one after the other, as the danger increases.

One or other of these instruments would be placed in well-determined and suitable positions in the workings, each station bearing a letter or number, while in a special office on the surface would be electric bells, with indicators, bearing corresponding letters or numbers, and surmounting a general plan of the colliery, showing the stations, with their letters or numbers, and also all the air-doors for directing the ventilation. Each warning appliance would be in electrical communication with its bells, and the air doors would be furnished with contacts and connected by wires with the ventilation office, so that the *employé* might know that his instructions had been followed, and that all was in order for ensuring a proper distribution of air. With such an arrangement, a glance at the indicator and at the plan would be sufficient to obtain cognisance of any danger, of its imminence, and the direction from which it threatens. At the same time, the bells in the safety lamps would warn the miners to put out their lights and retire to a place of safety; or the lamps might be made to extinguish themselves before the critical moment arrives, and before extinction takes place in the ordinary safety lamp.

General Notes.

Institute of Naval Architects.—The annual meeting of this institution was held on Wednesday, Thursday, and Friday, March 29th, 30th, and 21st, in the rooms of the Society of Arts, under the presidency of Lord Ravensworth, who delivered an opening address. Mr. D'A. Samuda read a paper on "Armoured Ships and Modern Guns," which was raised a long discussion. Papers followed on modern merchant ships, and on engines of different types. A discussion arose on a paper by Mr. W. H. White, Chief Constructor of the Royal Navy, "On the Revision of the Tonnage Law." Other papers were read on "Launching Velocities," "Tonnage Measurement," "Moulded Depth in Relation to Freeboard;" papers by Mr. T. C. Read and Mr. P. Jenkins on the "Transverse Strains on Iron Merchant Vessels;" by Mr. J. Harvard Biles, on "Progressive Trials;" by Mr. H. H. West, on the "Qnality of Materials used in Shipbuilding," &c.

Madrid Mining and Metallurgical Exhibition.—In consequence of the representations made to the Spanish Government that the time for preparation was too short, it has been decided to put off the opening of this Exhibition until April, 1883. The duties on foreign goods must be guaranteed by two merchants living at the port or town of importation, in the event of their not being re-exported after the Exhibition.

The Melograph.—Under the name of Melograph M. J. Carpentier has invented an electrical instrument for recording musical notes. The melograph is put in electrical communication with an harmonium a few yards distant, the notes being connected by wires with punches, which, when the electric current passes, on the notes being struck, pierce a band of paper. With the band of paper thus prepared, the melograph is capable of reacting upon the harmonium, by causing it to repeat, as often as may be desired, the air that has been played. The perforated band is caused, by wheel-work, to pass in front of small brushes of silver wire, each in electrical connection with a note of the harmonium. When a hole passes under one of these brushes, contact is made, the current passes, and each note, placed before a small electro-magnet, is depressed, and produces a sound, just as when played by the finger. M. Carpentier hopes to be able to reproduce, upon the musical stave, the notation obtained by the holes, so as to make the instrument record an improvisation.

Academy of Sciences, Paris.—Among the prizes awarded for last year are the following:—Extraordinary Prize of 6,000 fr. (£240), for progress tending to increase naval power, divided between Lieut.-Colonel Sebert and Lieut. Brault. *Prix Montyon*, awarded to M. Armengand, Aîné, for his numerous publications on mechanics, including treatises on the steam engine, water motors, sawing machines, &c.; and to M. G. Lire, formerly director of the Ecole d'Orlogerie, Besançon, for the invention of appliances for scientific demonstration, including the polytrope, the gyroscopic pendulum, the devioscope, &c. *Prix Plumey*, to Capt. Fleuriais, for his improvement in instruments connected with navigation. *Prix Fourneyron*, to M. Mekarsky, for his compressed-air tram-cars. *Prix Lecaze*, to M. Gaston Planté, for his important inventions connected with electricity, including the accumulator and the rheostatic engine. The amount of this prize (10,000 frs.—£400) has been handed over by M. Planté to the Société des Amis des Sciences.

Parcels Post.—The following are the numbers of parcels sent during the year 1880 by parcels post in those countries where that service had been adopted:—

Germany	67,319,700	parcels.
Switzerland	6,535,735	,,
Austria-Hungary......	4,538,394	,,
Denmark	1,366,942	,,
British India	1,074,262	,,
Belgium	960,000	,,
Russia	839,350	,,

Society of Telegraph Engineers and of Electricians.—At the meeting of this society on Thursday evening, 13th inst., the following papers will be read:—"Description of a form of Battery of low internal resistance," by F. Higgins; "Tests of Incandescent Lamps with special reference to the decrease in the resistance of the Carbon with an increase of Electro-motive Force," by Andrew Jamieson.

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FRIDAY, APRIL 14, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COMMERCIAL EXAMINATIONS.

The Council have received a number of applications from Institutions in Union with the Society, asking that the Society's Commercial Examinations should be revived. The Council have, therefore, determined to renew the Examinations in the same subjects as heretofore. The programme is now in course of preparation, and will be issued as soon as ready.

CHANNEL TUNNEL.

As it is probable that many members will wish to attend the discussion on the Channel Tunnel, to be opened by Sir Edward Watkin at the ordinary evening meeting, on Wednesday, the 19th inst., it has been thought desirable to make special arrangements for the meeting. The usual rules for the admission of members and their friends will therefore be suspended. Admission will be by ticket only, and no person, whether a member or not, can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued to members desiring them, in the order in which they apply. Each ticket will admit one person, and is transferable. Not more than a single ticket can be issued to any one member. The tickets have now nearly all been disposed of, but a few still remain, which will be sent to the first applicants.

ADDITIONAL LECTURE.

Dr. Richardson, F.R.S., will deliver a lecture on Friday, 28th April, at 4 p.m., before the Society of Arts, on "National Necessities as the Bases of National Education." Mr. E. Chadwick, C.B., will preside.

ANIMAL LOCOMOTION.

The publication of Mr. Muybridge's lecture on "Animal Locomotion," delivered on Tuesday, April 4th, has been postponed at Mr. Muybridge's particular desire. It will be printed in the *Journal* shortly.

Miscellaneous.

A YACHT VOYAGE THROUGH THE CANAL DU MIDI OF FRANCE.

By Admiral Lord Clarence Paget, K.C.B.

Miranda, Toulon.

I have been asked by several yachting friends to describe a trip, offering some novelty and interest, from England to the Mediterranean, *viâ* the Canal du Midi, of France, and have consequently prepared the following account, which I trust may interest the readers of the *Journal*:—

The *Miranda* is a galvanised steel screw steamer, built by Messrs. Halsey, of Wandsworth, of the following dimensions:—85 ft. length over all, and 11 ft. extreme beam. Her draught of water with her small, three-bladed canal screw, is 4 ft. 2 in., but, being constructed with the screw shaft very low down, and a break in the keel, she carries for sea-going purposes a larger screw, which increases her draught to 4 ft. 8 in.; her height above water-line, with funnel lowered, is 8 ft. She has a compound engine and a surface condenser. She carries 6½ tons of coal, equal to about eight days' consumption at full speed, and water for a fortnight. Her accommodation consists of a forepeak, with two sleeping berths; a cabin, with two bed places for the mate and engineer; a double-bedded sleeping-cabin; and a single-bedded ditto, with bath-room, washing-room, and closet—all before the engine-room; and abaft, she has a saloon and pantry, and cooking place, with steward's berth. She carries five hands and a pilot. I mention these few details as the sequel will show their importance to those who undertake this cruise.

The start was not propitious, various circumstances detained the vessel, and she found herself off Beachy Head at the commencement of the furious gale of 14th October last; she got, however, safely into Ramsgate, and so on to Cowes, thence to Dartmouth, where she was detained a considerable number of days by bad weather, and at last she had a good run across Channel to Ushant on November 6th. Passing through the Passage du Four, her coal bunkers took fire, and she put into Brest, restored her coals, and proceeded on southwards, but bad weather drove her into the several ports of Locktudy, Port Louis, and Croisic. Finally, she arrived at Bordeaux, on November 19th, having proved herself a right good little sea boat.

Having completed coal and water, unshipped her masts and davits, and made all preparations for canal work, we started on November 26th from Bordeaux, passing under the bridges and into the Garonne to La Reole, where commences the canal.

Here I must pause and give an idea of this great work which unites the ocean with the Mediterranean through the heart of France. Originally, the canal, which immortalised its constructor, P. P. Riquet, was only intended to connect the head waters of the Garonne at Toulouse with the Mediterranean, and it was opened with great pomp and ceremony by Louis XIV. in 1681, but it was soon found inadequate to the purposes required, as the Garonne was subject to all sorts of vicissitudes of drought and floods.

It was not, however, till our own times that the "Canal Lateral," between Toulouse and near Bordeaux, has been completed, and, curiously enough, just at the moment when the railway between Bordeaux and Cette has almost entirely absorbed the traffic. So here is this magnificent canal, with its 99 locks and its viaducts and bridges comparatively unused, save by an occasional barge loaded with wine. Nevertheless, it is kept in admirable order, and the passage can be made, with certain precautions, without any difficulty.

A pleasant, though not very picturesque voyage of thirty miles of river, brought us to the entrance of the canal. It was necessary to put on our canal screw before entering, so we laid the vessel on the ground, and entered on the following tide, through the lock, which is double, or rather twin, so that two vessels can pass at the same time. The dimensions of this, and indeed all the locks, are as follow:—Length, 28 metres; breadth, 5·80 m.; depth, 1·60 m.; and the height of bridges varies, but no vessel is allowed to pass which is higher above the level of the canal than 2·72 m.

Thus, it will be seen that we had about six feet of length, and five feet of width, to spare, one foot of height, and one foot under our bottom; nor is this by any means too large a margin, since, however well a vessel may be steered, and however quickly stopped, it is impossible at all times, particularly if there be a strong breeze, to ensure her entry into the locks with exactly sufficient speed. Moreover, it is quite necessary that a boat should be afloat, to make a rope fast to the shore, where the canal has very sharp curves, as is the case in the old part of it, between Toulouse and Cette; and inasmuch as the boat cannot be hoisted up to davits or inboards, it will be manifest that room must be left for her in the lock. We had just room under the stern for one 13 feet boat athwart. The safe passage through the first lock and under the first bridge caused us pleasant excitement, for although I had taken all precautions to ascertain the matter beforehand, nevertheless I was somewhat anxious, having come so far, that we should not have to return disappointed.

Here I feel bound to express my sense of the kind- and attention we experienced from all the authorities of the Canal du Midi. M. Moffre, l'Ingenieur en Chef, who resides at Toulouse, and gave me the pleasure of his company when we arrived there, had given orders that an officer should go with us the whole way to see that there was no detention at the locks, and we, besides, had an excellent pilot, whose name I desire to make public because of his merits, which included those of purveyor and cook! Although on several occasions our ragout was somewhat damaged by Serre (such is his name) having to steer the vessel into a lock at the critical moment when the casserole required his attention, nevertheless we fared sumptuously on the whole; but let no one suppose that in passing through the heart of France victuals can always be procured. There are distances of 12 or 15 miles without shop or even a cottage.

We were satisfied to have accomplished our first lock, and made fast opposite the house of the "Chef du Section," of which there are seven on the canal. He and his lady paid us a visit, as did the curé and principal inhabitants of La Reole. Next morning, the 28th, we fairly tackled the business, and accomplished that day 11 locks, stopping at Buzet. It would be tedious to describe our daily routine, and I need only remark that we took advantage of all the daylight—at this season only about 8½ hours—and accomplished some 35 to 40 miles per day, always ascending, till we arrived at Toulouse on the sixth day. This "Canal Lateral" follows much the course of the Garonne. It is a splendid work, and is kept in beautiful order. The grand features are the bridges which carry the canal across the Garonne and other rivers. There are three, but by far the grandest and most interesting is that at Agen, where we found ourselves in mid-air, with the river, the railway, the high road, and part of the town far beneath us. The centre arch is a hundred feet high. After leaving Agen, the scenery became picturesque and sometimes grand; but to really enjoy this trip it should be taken before the fall of the leaf. The whole length of the canal is lined on either side by poplar, plane, and other trees, many of them of great height, so as almost to shade the vessels passing. The locks are admirably managed, and it is surprising how little delay they cause—always supposing that there is no vessel to take precedence; but whether by chance, or that orders had been sent on to keep the road clear, we were rarely detained, and the average time in passing through was about five minutes. As we approached Toulouse, the air became keen and the nights frosty. Our "Chef du Section," who always accompanied us, informed me that some years since the canal was frozen up in the middle of December, and we consequently delayed as little as possible, and only spent a couple of days at Toulouse, which I regretted, as besides being a pretty town, it is especially interesting as being the grand central depôt of the canal, and junction with the old "Canal du Midi," a name which has outlived the original title of Louis XIV., who christened it "Canal de Languedoc." Here, or rather a few miles to the eastward, are the numerous reservoirs and alimentary canals which bring the waters from the "Montagnes Noires." We could not stop to see them in detail, but could trace their outline far away in the distance.

When the celebrated engineer, Vauban, came to inspect these works, he was astonished, and exclaimed that one thing was wanting only, namely, a monument and statue to the founder. This has since been rectified, and a grand obelisk is visible at the source of the canal. The story of Pierre Paul Riquet is that of many, nay, of most, great patriots—he met with scant assistance from the Government, and strenuous opposition from his countrymen; he was treated as a madman, and died of a broken heart before the great work was finished. His career seems to have been very similar to that of an illustrious man of our own day—Lesseps—save and except that the latter, happily, has been spared to see the final achievement of his splendid work. He had, however, one attribute which is not common among inventors—he knew how to strike a bargain; and his contract still enriches several families, his descendants, especially the Caramans.

On December 5th, we arrived at the summit of the canal, and it was interesting to observe the alimentation going both ways. Here the whole character and structure of the works changes; instead of many miles of straight reaches of uniform width of about 100 feet, the canal becomes tortuous to a degree which is almost absurd, but which is accounted for by the fact that, in Riquet's day there was no law "d'expropriation," and he had to make a bargain with every little landowner for permission to pass through his grounds, and being in many cases refused, he had to cut away in another, and often opposite direction, The locks here are also peculiar, being oval-shaped, to admit of two boats abreast; the effect of this is, that although on the map, Toulouse is at least two-thirds of the distance from Bordeaux to Cette, it is, by the canal, not quite half-way.

These sharp curves are inconvenient, as it is necessary to turn the corners very slowly, for fear of running into vessels coming in the opposite direction, and often they are so very acute as to necessitate stopping the engines and using poles, and sometimes ropes, to get round the corners.

Another peculiar feature of this part of the canal is the constant recurrence of multiple locks. On first approach to double, treble, quadruple, and even quintuple locks, one feels somewhat like going over a precipice, but this soon wears off, and in reality, the ground is got over quicker than with single locks.

The famous octuple lock at Beziers only required half-an hour to accomplish, and it is one of the most wonderful features of this canal, it is like going down a steep ladder from the top of a cliff to the valley below. Our passage must have been a source of amusement to the natives, judging by the crowds which met us at each stopping place. I never could quite understand the exact cause of this. I asked M. Moffre, to whom I have already alluded as the obliging and amiable chief, but he did not satisfy me by saying it is the first steam yacht except one, which belongs to the Emperor of Austria, and which passed through five years ago.

It so happened that my friend and agreeable companion, Mr. Percival, the British Consul at Bordeaux, accompanied me, and I fancy the innocent people must have supposed we were rehearsing an intended voyage of some royal personage, indeed this was hinted to me; anyhow we were received with, if I may ungratefully express it, too fervent demonstrations, which culminated in the military governor of Carcassone coming out on a prancing charger to welcome us, and caracolling along the towing path with us into the town. What a curious old place is Carcassone, said to be the oldest town in France, and I should think, from its appearance, it might claim still greater antiquity.

But how sad is the aspect of this country, till lately the favoured land of the grape, and of the famous Vins du Midi, now a desolate wilderness. As far as the eye can reach, in every direction, are vineyards desolated by the terrible Phylloxera, and the poor people are now rooting up their vines to sell for firewood. It is, alas, spreading in every direction, and there seems no cure. A more horrible aspect than a vine attacked by these insects cannot be conceived; seen through a microscope it is a living and moving mass of insects, which assume various forms, from the chrysolic to a diminutive moth, and in that state they fly to fresh plants and deposit their eggs.

From Carcassone we descended rapidly by multiple locks to the plain of Agde, having always as a grand back-ground to the south the range of the Pyrenees, but this plain is anything but picturesque, being rocky and barren. Here we pass what the ignorant and misguided people of Riquet's days thought would be a barrier to his great work. A sharp spur of the "Montagnes Noires" here juts out into the plain, which looks like "thus far, no farther," but he was equal to the task, and set to work to tunnel an imitation of the only tunnel existing in those days, the grotto of Pausillipo at Naples, which he visited on purpose, and it is exactly similar and about the same length. Who does not remember the odd mysterious passage, high enough to pass a line-of-battle ship through? A part, unfortunately, has given way, and necessitated arching the roof, which has somewhat marred the effect, but it is still interesting and imposing. From hence, a sharp descent through several multiple locks, brings us to the level of the Mediterranean, whose blue waters are seen in the distance; and on Saturday, the 10th of

December, being our 14th day since leaving Bordeaux, we emerged from the canal into the Etang du Thau, an inland sea, several of which abound on this coast, and must have belonged at some former period to the Rhone, whose delta resembles that of the Nile, and continues from hence nearly to Marseilles. At the mouth of the Etang is the town and seaport of Cette, which we reached in the afternoon.

The canal is passed, and we are in the Mediterranean. Cette is becoming celebrated, or more properly, notorious; it is the principal seat of adulteration, open and unblushing, of the wines of France and Spain. Here are millions of barrels all along the quays in every street, on countless waggons and railway trucks, and in dozens of ships marked with the brands of Medoc, Burgundy, Frontignac, and other wines such as Sherry, Madeira, Malaga, &c., innocent of any connection with grapes or with a modicum so small as to be merely nominal, and they are sent all over the world. The Government is powerless to curb this traffic, and can only step in if deleterious drugs are mixed; but the curious part of the story is that several samples which I tasted are really not at all disagreeable. England, of course, is the greatest dupe, but even the French are obliged to submit, as there is great difficulty, even in this wine-growing country, of getting pure wine. It is a busy place, and far from dull, with its teeming population and shipping. I might here lay down my pen, and say the task is accomplished: the *Miranda's* masts are again stepped, her sea-going gear set up, and her sea-going propeller shipped, and we are off to Cannes to winter in that lovely climate, but my yachting friends will expect some general advice concerning this novel mode of visiting the Mediterranean. Let no one suppose it is to be lightly undertaken, like a coasting cruise.

The canal is subject to several maladies. In winter, it is sometimes frozen in its higher parts, near Toulouse. It is subject to droughts, and when I passed Toulouse, the engineer-in-chief told me he had doubted whether he ought to telegraph to me at Bordeaux not to attempt the passage, as they had not had a drop of rain for six months, and the reservoirs on the Montagnes Noires were very low, and getting lower every day, so that there was barely four feet in parts, consequently I broke one of the blades of the propeller, though I was never actually stopped. Each year, and usually in August and September, what is called "chômage," or cleansing and repairing, takes place, during which the canal is closed.

A serious mishap befel me, and nothing but the exertions of an excellent engineer surmounted the bother. Before leaving England, I made all sorts of inquiries in Paris as to the facilities which Cette offers for docking vessels. It will readily be understood that on the ocean or western side of France, where there is a good rise and fall, nothing is easier than to beach the vessel and change the propeller, but on the Mediterranean side there is no rise and fall, consequently, either a dock or a slip of some sort is required. I was shown, in Paris, plans of Cette, exhibiting docks and slips in abundance, but on arriving at that place, I found these things only existed on paper, and the folks there are so absorbed in their occupation of adulterating wine, that they have neglected this necessary appendage to a Mediterranean port. We succeeded in changing the propeller by wading under the vessel's bottom,

The engines I should recommend would be compound surface condensing, with power to cut off the condensing gear, and use high pressure while in the canal, as the constant and sudden stoppage and backing is very trying to the condensing gear, which in my case fairly broke down. No harm comes to the boiler, as the water is fresh.

I have already said that 85 ft. length, and from 11 ft. to 12 ft. beam is as much as is advisable, and on no account should the draft of water exceed 4 ft. 2 in. As to height, there is a fair margin, and I do not think that 9 ft. above the water line would actually scrape the crown of the bridges. There is no coal, or at least no coal fit for use to be procured at any of the ports, Bordeaux and Cette excepted, so a vessel should stow 7 to 8 days of that article. A pilot is of great use, particularly at the locks, not to mention purveying at the principal towns, and if he adds to his merits that of cooking, as mine did, no one will regret shipping one, although it is not required by the authorities.

I will not close this account without adverting to the origin of this scheme. Many years ago, in the historical "Gossett room" of the House of Commons, the illustrious engineer Stephenson consulted me about a yacht on the "wave line" principle, which was then some what in vogue, and which was supposed to combine speed and steadiness at sea. I need not detail my objections to this form, which I laid before him, but I asked him what he wanted to do, and his reply was, to go as far as possible, and never to be at sea at night. I replied, given certain conditions, he might leave England, and navigate either to the Baltic or to the Mediterranean, passing his nights in harbour.

Those conditions were, first of all, that his engine should not break down; secondly, that the dimensions of his vessel should not exceed certain limits, and thirdly, she should have a running speed of nine knots, and stowage of coal for 150 hours. The company laughed me to scorn, but this project has actually been carried out almost in its integrity by the *Miranda*, for she has only passed two nights at sea, and that was because she was hurried out to Bordeaux by the builder who had engaged to deliver her there.

It is a curious fact that there is scarcely a distance exceeding 60 miles where a vessel of her dimensions may not take shelter with perfect safety. She crosses from the Isle of Wight to Cherbourg, or she may cross to Dieppe or Havre, and coast along the west coast of France; she may enter the Canal d'Ile et Rance, at St. Malo, descend the Vilaine River, and coast to Bordeaux, touching at a dozen little harbours; she then goes by the Canal du Midi to Cette, and here she finds ports the whole length of France and Italy (with but one break between Naples and Messina of 190 miles) to Malta and so on, or along the coast of Spain; but she must have a good engine, and stow plenty of coal, and she should have abundance of time, so as not to force her passage, as her dimensions are not for real sea-going, but for coasting.

I have already adverted to the uniform kindness I received from all the authorities, and I have been requested by them to make known to any yachting gentlemen that they are ready to give every information and assistance, and are glad indeed to see their splendid canal *egayé* by the sight of the English flag.

The only other item to which I need allude is the cost of the trip, and this is not the least of its merits. It seems incredible, but the only charge made by the canal authorities for the passage of the 99 locks is under 90 francs.

REPORT ON THE EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

There can be but little doubt that photography is destined to play a part of considerable importance in connection with commercial and scientific operations, and there is excellent reason to suppose that the increased interest which has of late been manifested in relation to practical and theoretical photography arises, to a great extent, out of recent developments of the gelatino-bromide process.

When it was announced that Captain Abney would, during the session 1881-1882, deliver a course of Cantor lectures on Photography, it soon became abundantly evident that unusual interest would be attached to this course of lectures, and under these circumstances it was considered desirable to organise a technical exhibition of photographic appliances and processes in connection with the course. The success of these efforts of the Society to meet the growing interest taken in photographic matters may be well illustrated by the reproduction of extracts from a few paragraphs and articles which have appeared, not only in the technical and scientific journals, but also in magazines and newspapers of a general character. And it may also be noted that the lectures, together with the technical exhibition, have been regarded by the press and the public as being part of the same organisation, and strictly relative to one another. The tone of the technical journals is fairly illustrated by the subjoined quotation from the issue of the *Photographic News* immediately following the delivery of Captain Abney's first lecture:—

"It has been our lot to attend several courses of Cantor lectures at the Society of Arts, and we have, on these occasions, been not only initiated into the mysteries of sugar refining, wool dyeing, bread making, and the coal-gas manufacture, but have also heard the late Rev. Arthur Rigg explain, with all the ardour of an enthusiast, the principles upon which mechanical tools are constructed; and have listened to Professor Colvin when he told how Greek and Roman art are sealed to him who is not properly versed in classic lore.

"We have, however, not yet seen such a large or interestedly expectant assembly waiting for the advent of the Cantor lecturer, as was the case on the occasion of Captain Abney's first lecture, which was delivered on Monday evening last. Not only were all seats filled, but the approach to the lecture-room was densely packed with both men and women, who evidently regarded a remote chance of seeing and hearing as a sufficient recompense for considerable personal inconvenience; while many a one who had either been unsuccessful in obtaining the necessary ticket of admission, or had been dismayed by the remote chance of being able to find even standing room, took refuge in the library of the institution, where the collection illustrative of photographic technology was arranged; and we are told that it is intended that this technical exhibition shall be for a few weeks accessible to those interested in photography. . . . . Captain Abney's lectures will probably prove to be the most successful course which has yet been given in connection with the valuable foundation of Dr. Cantor. . . . . The Technical Exhibition, which has been organised by Mr. Trueman Wood, in connection with Captain Abney's course of lectures, was opened a couple of hours before the time of the lecture, and we must heartily congratulate the indefatigable Secretary of the Society of Arts on the success of his efforts to get together a collection which should be fairly representative of the present condition and byegone phases of this branch of applied science. On entering the Library, where the principal exhibits were arranged, the absence of large shop-window-like stacks, of highly-polished mahogany, and brilliantly-lacquered brass was striking. In fact, the first object that met our view as we entered was a dingy apparatus nearly resembling a small and deformed cucumber-frame, which one out of a group of three persons who were examining it informed us was the first Woodburytype press, after which our informant led us to the other end of the room to see the first mould—an electrotype—and an impression from it."

The same journal, in reference to the last lecture of Captain Abney's course, says:—

"On Monday evening last the final lecture of the course was delivered, and so far from there being any sign of diminished interest on the part of the audience, there was, if possible, more determination shown in crowding into the room, and an increased anxiety to catch every word that was said. Our prediction that Capt. Abney's series of Cantor lectures would be the most brilliantly successful course which has yet been delivered, appears to have been abundantly fulfilled, and sincere congratulations were abundantly showered on the Captain."

An article which appeared in *Engineering* gives so excellent and succinct an account of the most notable features of the Exhibition, that a considerable portion of it is here reproduced:—

"The Exhibition of Photographic Appliances was densely crowded, and those present were so much interested, that it was found to be by no means an easy matter to clear them out when the time for closing arrived. Very few pictures are shown, and these are exhibited in most cases to illustrate some process or mode of working. Among these may be mentioned Mr. Francis Galton's composite portraits, as being of equal interest to the artist, the physician, the ethnologist, the biologist, the physiognomist, and the photographer. By means of a special apparatus, which is exhibited together with the results, a number of portraits are brought to the same scale, and so averaged that the general features and characteristics common to all are preserved, while the special peculiarities of each are lost. In this way ideal portraits are obtained which are, in some cases, of extreme beauty, and which recall the efforts of such masters of facial expression as Murillo or Franz Hals. Mr. Galton, whose work on "Hereditary Genius" will take a permanent place among the characteristic results of the labours of the nineteenth century, has made certain branches of investigation into the relations of body and mind, peculiarly his own; and his skill in mechanical arrangements has enabled him to obtain results of unexpected value. Mr. George E. Chapman, of Victoria-street, Westminster, shows the admirable work which can be done by Pellet's photo-cyanofer process for copying engineers' tracings. This method is very rapidly and easily worked, and as it gives intensely blue lines on a white ground, the copies may be coloured in the ordinary way.

"The main part of the Exhibition consists, however, of apparatus and appliances used by those engaged in photography. Grover's system of glazing by means of lead strips instead of putty is illustrated by a small model of a photographer's glass house; and Balmain's luminous paint is shown as applied to the production of photographs which are visible in the dark, a transparent picture on glass being backed up with a layer of the paint.

"Modes of printing photographs by mechanical methods are well illustrated; the various photo-lithographic, photo-collotype, relief and intaglio process being made clear in their various stages by the exhibits of Mr. Griggs, Messrs. W. and A. Dawson, Mr. Woodbury, Mr. Dallas, and others; while various methods of permanent photographic printing, and the apparatus used, are illustrated by the Autotype Company, Mr. A. L. Henderson, and the Platinotype Company. A large proportion of the exhibits consists of apparatus which is now of the past, and another considerable section consists of appliances specially adapted for use with the new gelatino-bromide dry plates. Among these latter may be mentioned numerous ingenious contrivances for giving short but more or less accurately measured exposures, and apparatus for working dry plates in the open field. One of the most perfect arrangements of this latter kind is the new changing box of Messrs. Hunter and Sands, space and weight being economised to an unprecedented extent. We are pleased to see that the literature of the gelatino-bromide process is not neglected, as side by side with an interesting series of exhibits showing the rapid advance of the new process we notice Dr. Eder's exhaustive work on "Modern Dry Plates," and the "Year Book of Photography;" this latter is a comprehensive annual record of progress, both these works being issued in connection with our contemporary, the *Photographic News*. Those of our readers who take any interest in photography should not fail to visit this most important and complete Exhibition."

Although newspapers do not, as a rule, concern themselves much with photographic matters, and perhaps it may be said, do not show much knowledge of the subject when they do deal with it, it was satisfactory to find that flattering notices appeared in the *Times*, and most of the other daily papers; the following being a quotation from the *Sandard*:—

"Those, and no doubt their name is legion, who take an interest in the art of photography, will be well pleased if they pay a visit to the Exhibition of Photographic Apparatus, just opened in the hall of the Society of Arts, John-street, Adelphi. There they will have traced for them the history and gradual development of the art from the time of the daguerreotype, through its various gradations, down to the present date, when, by means of gelatine plates, objects in motion, such as express trains, and breaking waves in sea pieces, can be taken instantaneously. Indeed, so perfect has the art (or perhaps, the science) been brought, that outlines of figures and scenery can at present be struck in the 250th part of a second. In this Exhibition there are examples of photography where the film has been floated off on to a porcelain surface, into which it is burnt with enamel colours. For purely scientific purposes, photography is also shown to be of incalculable service —such as in meteorology, in automatically recording observations, &c. But, perhaps, that which will strike the visitor most forcibly is the composite portraiture, in which the members of a family—say five in number, are first taken individually, and then gradually blended, until, in the last reduction, the leading mental characteristic is prominently apparent A very curious specimen of this—say experiment—is on view in the Council Chamber."

During the time when the Exhibition was open, a paper on the subject of photography by artificial light was read by Mr. H. Van der Weyde, at a special meeting of the Society; and in this case a crowded audience was drawn together. It is interesting to note that a permanent museum of photographic interest is likely to grow out of the technical exhibition, the South Kensington authorities having taken the matter in hand.

It is not intended to in any sense review in detail the objects exhibited, as the catalogue itself affords fuller and more minute particulars than we can find room for in the present report; but it may be of interest to notice briefly some various classes of objects exhibited.

Numerous illustrative examples of old and now almost disused photographic methods were shown, together with the appliances used in their production; the South London Photographic Society, Messrs. Ross and Pringle, Mr. William Bedford, Mr. W. M. Ayres, Mr. J. Werge, Mr. Baynham Jones, Mr. J. Pearson Hill, and others contributing exhibits of this class, and in many cases the beauty of the results obtained by the Daguerrotype process was so striking as to elicit much comment. Photo-mechanical work was, perhaps, better illustrated than any other branch, fine examples of relief and intaglio engraving being contributed by Messrs. Dawson, of Chiswick, Mr. Dallas, and some few others; while the Woodburytype and Collotype processes, together with their applications, were abundantly illustrated by Mr. Woodbury, the Woodburytype Company, Mr. Leon Vidal, and the Autotype Company. Mr. William Griggs showed an interesting series representing photo-chromo-lithography, and Mr. Bolas contributed a series of examples illustrating certain photo-mechanical methods; several of these examples having been produced at the lecture table, on the occasion of his late course of Cantor lectures on photo-mechanical printing processes. The commercial importance of the various photo-mechanical printing methods seems on the point of considerably increasing as a means of illustration for books and journals. Other photographic printing methods were well represented, the platinotype process being shown in its various stages of advance, and all the appliances for practically working it being placed in order and ready for use. The so-called carbon, or autotype printing, was brought prominently forward by several exhibitors, but the most interesting exhibit relating to this subject was undoubtedly the very complete series which Mr. E. W. Foxlee has prepared, in order to illustrate the continuating action of time in carbon printing.

Apparatus specially adapted for the requirements of the gelatino-bromide process was shown in abundance, comprising arrangements for finely dividing and washing emulsions, coating plates, and drying or washing negatives; while non-actinic lamps, instantaneous shutters, and portable cameras, fairly abounded. Several changing boxes of excellent design were shown, and in relation to this subject may be mentioned Mr. Warnerke's apparatus for testing the rapidity of exposure with any given shutter. It consists of a blackened disc, which describes one complete revolution in a second; and a circular hole in this disc serves to allow any highly illuminated surface placed behind to impress on the plate an arc corresponding to the length of the exposure. The principle exhibitors who contribute dry-plate appliances are Mr. W. Bedford, Mr. W. N. Ayres, Mr. Warnerke, Messrs. Rouch and Co., Mr. A. L. Henderson, Mr. T. Werge, Messrs. Marion and Co., Jas. Lancaster and Son, Messrs. Hunter and Sands, Messrs. Shew and Co., Messrs. Watson and Son, Messrs. Fallowfield and Co., Mr. B. J. Edwards, and the Sciopticon Company.

Several other exhibits were of especial interest in connection with the gelatino-bromide process; as, for example, negatives taken in 1871 by Dr. Maddox, transparencies made in 1873 by Mr. Kennett, and Mr. Henderson's moonlight picture, which latter was exposed for no less than seven hours.

Mr. Francis Galton's apparatus for composite portraiture formed one of the most interesting objects shown; the researches of this gentleman opening out a new path for photography, and serving to link photographic portraiture with the results obtainable by the hand of a master artist.

Although many other exhibits fairly deserve special notice in this place, the necessity for a more detailed account is, as before notified, removed by the circumstance, that the catalogue (issued with No. 1,524 of the *Journal* of February 3) contained, in most cases, tolerably detailed descriptions.

The Exhibition was open during 24 days, and it is calculated that the number of visitors was over 1,200.

Correspondence.

SEWAGE AT EASTBOURNE.

Through the courtesy of Lord Cochrane and the directors of Shone's Drainage and Water Supply Company, Limited, I had an opportunity, on Thursday, the 6th inst., of assisting at the inauguration of new works of sewage collection, which have been executed upon the Shone system at Eastbourne. More than a hundred gentlemen, engineers and others, interested in the subject, from all parts of the country, accepted the invitation, and were rewarded by witnessing a practical illustration of what can be done by local enterprise when stimulated by self-interest, under the guidance of men of "light and leading." When Dr. Richardson projected his earthly paradise, dedicated to the goddess of health, selecting Worthing as the site of the new city, Eastbourne seems to have taken the hint and the lesson to heart. The result is the successful completion, on Thursday, of the first stage towards the practical realisation of an ideal which many sceptics at the time deemed to be visionary and unattainable. The main sewer at Eastbourne, at its starting point, is 25 feet above the level of that part of the town, which was once a rustic dell, and now the fashionable resort of visitors and residents alike, on the estate of that sagacious nobleman who may be described as the Aladdin of municipal enterprise. This was the initial difficulty. The second is common to all seaside resorts which depend upon a tidal outfall for the disposal of their accumulated sewage, lying stagnant, or backing up in huge cavernous constructions, ycleped sewers, but in reality, subterraneous reservoirs and elongated gas factories. Of course, there were the usual crop of expedients for coping with these difficulties. First, a separate system of collection for the lower town, and precipitation works in the bottom of the dell. Secondly, a tunnel under the marine esplanade, direct into the sea, after the flagrant example of so many towns upon the same coast. Thirdly, a deep, capacious sewer, of metropolitan proportions, through the bowels of the earth, with the inevitable pumping machinery at the outfall reservoir, to lift the accumulated sewage into the long-suffering sea. Fortunately, all such illusory methods were rejected, and the sewage of the lower is lifted into the main sewer of the upper town, by means of compressed air, working at an effective pressure of about 12 lbs. on the square inch, and supplied automatically at a depth of 22 feet below the surface, without need of supervision, or any charge for attendance, except at stated intervals. We descended by an easy flight of steps into a kind of grotto paved with tiles, lighted with gas, cool, quiet, noiseless and inodorous, the only sound perceptible being an occasional sigh from the compressed air as it escaped through the exhaust on its course to ventilate the old drain after each successive discharge. The motive force thus utilised serves a double purpose, not only by forcing the sewage from the ejector on to the higher level, but also ensuring that thorough ventilation of the drain, which renders the formation of noxious gases well nigh impossible. This compressed air is conveyed from the outfall, two miles distant, where a 5-horse power engine works two of Sturgeon's ordinary compressors; and the gauge in the grotto indicates to the inquirer that this effective pressure is transmitted throughout the intervening distance, in pipes of 2½-inch diameter, without any appreciable loss by leakage whatsoever. Arrived at the point of outfall, the collected sewage is forced into the sea, at all times of the tide, and in all states of wind or weather, thereby securing to the inhabitants of this favoured town the inestimable benefit of sewage always in motion through sewers of moderate capacity, effectually ventilated by the same force which gives the impetus and keeps the sewage in motion; this at a cost for oulay of capital and working expenditure so insignificant, that it must cause the ratepayers of some of our towns to bite their lips with envy and disappointment. I am not in a position to give the exact details of this expenditure, but the information will doubtless be forthcoming from those who are best competent to give it. Having, I trust, written enough to excite the curiosity of your numerous readers, I have only to thank Mr. Wallis—the agent of the Duke of Devonshire, and an energetic member of the Local Board—to whose plucky initiative and very vigilant supervision the town of Eastbourne owes so much of its marvellous prosperity, for his lucid explanation of the advantages of the system to the assembled company—reminding him, however, that his task, and that of his coadjutors, is not yet completed; that having brought the undiluted sewage to the outfall, by methods so admirable, and appliances so economical, it is a scandal to continue the waste of material so rich in fertilising ingredients, and throw such potentiality of wealth to the (sea) dogs, in defiance of every law of mind or matter. I have reason to believe that the means of effective utilisation are close at hand, and that the same master spirit which directed the work of economic collection, and has piloted Eastbourne safely over the quicksands of sanitary illusions and professional extravagance, will not rest long under the imputation of a half-hearted policy, which collects sewage only to waste it in the teeth of all experience, and stops short of a logical conclusion to an otherwise great and exemplary work.

C. N. Cresswell.

1, Hare-court, Temple, April 12, 1882.

PUMICE-STONE.

In a recent publication, "Notizie Statistiche sulla Industria Mineraria in Italia dal 1860 al 1880," from which Messrs. Toso and Baldacci's note on the production of pumice-stone in the Island of Lipari was taken, there is an interesting report by Messrs. Foderà and Demarchi on the deposits of Puzzolana, in the neighbourhood of Rome and Naples, which volcanic product, and not pumice-stone, is probably the substance to which Mr. W. Martin Wood alludes to in his letter to the *Journal*, p. 512. Puzzolana is largely used throughout Italy for hydraulic work, and especially for heavy masonry exposed to the action of the sea. According to his report, the best qualities of puzzolana from Naples are obtained at Bacoli, Montenuovo, and Bassano, where the deposits are of considerable extent. The cost, free on board, varies from one lira to 2·50 per ton, and it is often taken as ballast by coasting vessels to Mediterranean and Adriatic ports, where it finds a ready sale. Large quantities are being used for the harbour works of Geneva. The deposits of pozzolana, at Rome, are chiefly worked in the neighbourhood of the Tiber, and in consequence, can be readily shipped. The value of this material is about one lira per cubic metre at the ports. The annual production varies from 150,000 to 200,000 cubic metres, of which from 10,000 to 20,000 cubic metres is exported.

Puzzolana is used generally at Rome as a substitute for sand for making mortar, good sand for building purposes being scarce. It is usually mixed with fat lime in the proportion of 85 parts in volume of puzzolana to 15 of lime for ordinary rough rubble masonry, and 70 parts puzzolana to 30 parts lime for ordinary brickwork.

P. Le Neve Foster.

BLOOD POISONING AND BAD DRAINAGE.

My attention was called to a letter from Sir Henry Cole, which appeared in the *Journal of the Society of Arts*, of 24th March, on the above important subject. Imperfect drainage has always been a matter to which I have given my attention, and at the time of the alarming illness of the Prince of Wales, brought on by faulty drains, I arranged a system of ventilating drains and sewers, which I put in use at that time, and it remains in use still, answering the purpose most effectually. The system is simple, and, when once arranged, needs no repair. In order to carry it out, I connect the drains or sewers with a boiler fire, where the gases are withdrawn from the sewers, and in passing through the fire and up the chimney, are consumed, It has been applied to the Smedley's Baths at Matlock, Chorlton Union Workhouse, Manchester, Halifax, Huddersfield Infirmary, Oldham, Blackpool, West-vale, and other places, and has been highly recommended by medical men. In some of the places named, drains of one part of the town are connected to the furnace of a steam boiler, the draught of which is sufficient to draw the gases from the sewer, whereby they are burnt in passing through the fire. I am convinced that if the drains of dwellings, whether large or small, were connected to a fire, they would be all consumed, and such cases as those occurring at Bagshot-park, Peterborough, Westminster, and other places, could not possibly occur. The system I have suggested may be seen working daily at the places mentioned, and I am sure they only need to be seen to be understood and appreciated.

Henry Stott.

West-vale, near Halifax.

RECENT INVESTIGATIONS IN NITRIFICATION.

Mr. Warington's valuable paper contains some data with reference to the purification of sewage on land, which is of great practical use to those who are interested in the disposal of sewage, If I had been able to be present on that occasion, I should have contributed to the discussion the results of a series ot experiments that were made in 1880-1881, at Carlisle, with a view to determine the maximum volume of sewage which could be purified on land continuously. These experiments were conducted by Dr. Hatfield Walker and Mr. McKie of that town, and were carried out with a systematic observance of the volume of sewage applied, the time required for its filtration, and the analysis of the resultant effluents. The full details of these experiments are given in Chapter VI. of my recently published work on "Sewage Disposal," a copy of which is in the Library of the Society of Arts. The conclusion I deduced from these and other observations was, that a loamy soil having a well drained subsoil to a depth of six feet, is capable of purifying the sewage of about 600 people to the acre throughout the year, the sewage being applied so that periods of rest are afforded the land. The information furnished by Mr. Warington is valuable as marking, with other recorded data of a similar practical nature, the area or land requisite for purifying sewage to be determined within narrower limits than were previously recognised.

Henry Robinson,
M. Inst. C.E,

7, Westminster Chambers,
London, S.W.. 10 April, 1882.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

April 19.—"Discussion on the Channel Tunnel." To be opened by Sir Edward Watkin, Bart., M.P. Lord Alfred Churchill will preside.

April 26.—"Telephonic Communication." By Lieut.-Col. C. E. Webber, R.E.

May 3.—"The Fire Risks incidental to Electric Lighting." By T. Bolas, F.C.S. W. H. Preece, F.R.S., Member of the Council, will preside.

May 10.—"The Fish Supply of London." By Spencer Walpole, H.M. Inspector of Fisheries. W. H. Gladstone, M.P., will preside.

May 17.—"The Constant Supply and Waste of Water." By George F. Deacon. Sir Frederick Bramwell, F.R.S., Chairman of the Council, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock :—

APRIL 25.—"The Character and Social Industries of the Inhabitants of China, Japan, and Formosa." By the Hon. NOEL SHORE, author of "The Flight of the Lapwing." Sir RUTHERFORD ALCOCK K.C.B., will preside.

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock :—

APRIL 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. THOMAS and PERCY C. GILCHRIST.

MAY 11.—"The Recovery of Sulphur from Alkali Waste. Schaffner's process. A record of recent results." By ALEXANDER M. CHANCE, of Birmingham.

INDIAN SECTION.

Friday Evenings, at Eight o'clock :—

APRIL 21.—"The Mineral Resources of India, and their Development." By Prof. V. BALL, M.A., F.G.S., late of the Geological Survey of India. Sir JOSEPH FAYRER, M.D., K.C.S.I., will preside.

MAY 5.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE.

ADDITIONAL LECTURE.

FRIDAY, 28th APRIL, 4 p.m., "National Necessities as the Bases of National Education." By Dr. RICHARDSON, F.R.S. E. CHADWICK, C.B., in the chair.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 17....London and Middlesex Archæological (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Mr. H. B. Wheatley, "The Adelphi and its Site."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. Pullan, "A Notice of the Works of the late William Burges."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Dr. Wallich, "The Fallacy of the Materialistic Origin of Life."

TUESDAY, APRIL 18...Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. B. Tylor, "The History of Customs and Beliefs." (Lecture I.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. Dugald Clerk's paper on "The Theory of the Gas-engine."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. Stephen Bourne, "The National Expenditure upon Alcohol."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. Van Dyck, "The Modification of a Race of Syrian Street Dogs by means of Sexual Selection." With a preliminary notice by Charles Darwin. 2. Mr. J. E. Harting, "The Desirability of Adopting a Standard of Nomenclature when Describing the Colours of Natural Objects."

Royal Colonial, The Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. Henry J. Jourdain, "Mauritius."

WEDNESDAY, APRIL 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discusssion on the "Channel Tunnel." To be opened by Sir Edward Watkin, Bart, M.P.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. M. Whipple and Mr. T. W. Baker, "Barometric Gradients — Wind Velocity and Direction at the Kew Observatory," 2. Mr. George Dines, "Difference of Temperature with Elevation."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. Henry Prigg, "The 'Thing How' at Bury St. Edmunds." 2. Dr. Stevens, "Notes on a Bronze Sword, &c., found at Henley-on-Thames."

Sanitary Institute, 9, Conduit-street, W., 7¾ p.m. Mr. Henry C. Stephens, "An Obstruction by the Law to Sewage Dssposal."

THURSDAY, APRIL 20...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. P. H. Gosse, "Male Prehensarial Organs Ancillary to Generation in Butterflies." 2. Professor Dickie, "Himalayan Algæ." 3. Baron de Villa Franca, and Dr. Glass, "New Varieties of Sugar Cane by Planting in Apposition."

Chemical Industry, Burlington-house, W., 8 p.m. 1. Dr. Ramsay, "On Specific Volumes." 2. Mr. T. E. Thorpe, "The Behaviour of Zinc, Magnesium, and Iron, as Reducing Agents on Acidulated Solutions of Ferric Salts." 3. Mr. T. E. Thorpe, "The Action of Oxychloride of Sulphur on Silver Nitrate." 4. Mr. T. E. Thorpe, "The Action of Thiophosphoryl Chloride upon Silver Nitrate." 5. Messrs. F. R. Japp and W. Streatfield, "The Action of Acetone on Phinanthraquinone, both alone and in presence of Ammonia."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Metals." (Lecture I.)

Royal Historical, 22, Albemarle-street, W., 8 p.m. 1. Mr. Cornelius Walford, "Fairs, and the Part they have Played in the Commerce of Nations." 2. Mr. F. G. Fleay, "Queen Elizabeth's Soldier Poet."

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

FRIDAY, APRIL 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Professor V. Ball, "The Mineral Resources of India and their Development."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., Prof. Dewar, "Researches of St. Claire Deville."

Philological, University College, W.C., 8 p.m. Mr. A. J. Ellis, "The Dialects of the Midland and Eastern Counties."

SATURDAY, APRIL 22...Physical, Science Schools, South Kensington, S.W., 3 p.m. Prof. A. E. Dolbear, "Some Electrical Phenomena in connection with the Telephone."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Pollock, "The History of the Science of Politics." (Lecture I.)

ERRATUM.—Page 538, col. 2 (note), *for* 7 lbs., *read* 1 lb.

Journal of the Society of Arts.

No. 1,535. Vol. XXX.

FRIDAY, APRIL 21, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

THE LATE SIR HENRY COLE.

The Council have to announce to the members, with great regret, the death of Sir Henry Cole, K.C.B., Vice-President of the Society, who has been so closely connected with the Society and its work for many years, and had laboured so unremittingly for its welfare. The Council have no doubt that all the members of the Society will share this feeling with them. In another column will be found a short notice of the work effected by Sir Henry Cole during his long connection with the Society.

CHANNEL TUNNEL.

At the meeting of Wednesday, 19th, the discussion on the Channel Tunnel was adjourned to Monday, 24th inst. Cards of admission will be sent out to those who received cards for the first meeting.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Council have arranged to hold an Exhibition of Modern English Art Pottery at the House of the Society towards the end of May. The following firms have, on the invitation of the Council, kindly consented to exhibit specimens of their work :—Derby Crown Porcelain Company, Messrs. Henry Doulton and Co., Linthorpe Art Pottery Co., Messrs. Maw and Co., Messrs. Mintons, Messrs. Wedgwood, and the Worcester Royal Porcelain Works.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 19th, 1882; Lord Alfred S. Churchill, Member of the Council of the Society, in the chair.

The following Candidates were proposed for election as Members of the Society :—

Agelasto, John Michael, 22, Pembridge-crescent, Bayswater, W.
Gillespie, Rev. Charles George Knox, A.K.C., 20, Dawson-street, Manchester.
Gotto, Edward, M.I.C.E., The Logs, Hampstead, N.W., and 17B, Great George-street, S.W.
Greenwood, Arthur, M.I.M.E., Albion Works, Leeds.
Grenfeld, Henry Riversdale, Bank of England, E.C., and 15, St. James's-place, S.W.
Gurdon, William Brampton, Queen Anne's-mansions, S.W., and Treasury, S.W.
Harris, Henry William, Park-lodge, Eltham, Kent.
Hodgson, Charles, M.I.M.E., Signal Works, Kilburn, N.W.
Kennedy, Thomas Stuart, Meanwood, Leeds.
Laing, Arthur, Thornhill, Sunderland.
McKay, M.I.M.E., care of Messrs. R. and W. Hawthorn, St. Peter's, Newcastle-on-Tyne.
Parfitt, Edward Browne, 24, Maxilla-gardens, Notting-hill, W.
Philipson, John, M.I.M.E., 9 Victoria-square, Newcastle-upon-Tyne.
Price, Henry Sherley, Woodbury-lodge, Wickham-park-road, St. John's, S.E.
Reid, Ernest J., 16, Coleman-street, E.C.

Shervinton, Thomas Robert, 32, Arundel-gardens, Notting-hill, W.
Shilton, Alfred J., 40, Paradise-street, Birmingham.
Slater, Charles, F.C.S., 46, Clarendon-rd., Notting-hill, W.
Spencer, Eli, The Hollies, Werneth, Oldham.
Stanhope, Hon. Dudley H. E., Harrington-house, Charing-cross, S.W.
Tildesley, David, 6, Devonshire-villas, Brondesbury, N.W.
Veley, Victor H., B.A., F.C.S., University College, Oxford.
Wilson, James, M.A., F.C.S., 2, Essex-court, Temple, E.C.

The following Candidates were balloted for and duly elected Members of the Society:—

Brooks, J., Holmefield, Barr-hill, Pendleton, Manchester.
Evans, John, The Green, Stratford, E., and 134, Fenchurch-street, E.C.
Ferguson, Alexander, 38, Rockmount-road, Upper Norwood, S.E.
Marten, Edward Bindon, Stourbridge.
Mather, John, M.I.M.E., London and South-Western Railway, Locomotive Department, Nine-elms, S.W.
Mather, William, Salford Iron Works, Manchester.
Napier, James Murdoch, 68, York-street, Lambeth, S.E.
North, Frederic William, Rowley-hall, Dudley, and 34, Clement's-lane, E.C.
Richards, Josiah, Pontypool Iron and Tinplate Works, Pontypool.
West, Nicholas James, C.E., Foundry-house, Hayle, Cornwall.
Williams, Peter, 5, Bank-buildings, E.C.
Wilson, Wesley William, M.I.M.E., St. James's-gate, Dublin.
Wood, Edward Malcolm, 2, Westminster-chambers, S.W.
Wood, Lindsay, M.I.C.E., Southill, Chester-le-Street.

The Chairman, in opening the proceedings, said:—I have to express, what I feel that every member of the Society will feel, the deepest possible regret at having to inform you of the loss which this Society and Council have sustained in the sudden death of Sir Henry Cole. Sir Henry Cole, for the last thirty-seven years, has been a member of the Society, and during nearly all that time, off and on, he has been a member of the Council. At the time he first joined the Society, it was at a very low ebb, and I consider that the very prosperous position the Society now occupies is, to no small extent, due to his great activity and great exertions. There has seldom been a man who exhibited such fertility of conception, and such indomitable energy in carrying out his views and purposes, as Sir Henry Cole. The Council will feel that they have experienced a very great loss in his dealh, and I am certain that the Society as a whole will also deepl regret this loss.

The following address was delivered on

THE CHANNEL TUNNEL,

By Sir Edward W. Watkin, Bart., M.P.

The questions as to the Submarine Tunnel are:—

1. Can it be done?
2. How can it be done? If so:
3. How soon, and at what cost, can it be done?
4. Ought it to be done?
5. Can it be destroyed and defended, at will, if done?
6. And, ought scientific experiments to proceed finally to resolve the first proposition?—aye or no.

Here, in the hall of the Society of Arts—the question of associating our country with the Continent by a high-road under the sea-bed, will, at least, receive impartial consideration, and, in that belief, I shall incline to take the great ideas consecrated in the past history of the Society as admitted, rather than open up for an answer they hardly deserve, the prejudices buried, as we believed, in 1851—prejudices, however, which still haunt a few corners in Pall-mall. In this room, therefore, I take it for granted, that increase in the means of intercourse, or journeyings to and fro between nations, means—as cause is to consequence—the augmentation of wealth, and the expansion of civilisation. It means a great breaking down of barriers, a great letting in of light, the softening of national prejudices, an extension of career for the workman especially, but for all men of work, alike—all tending to peace and goodwill amongst men.

Bishop Hall records that "Bacon said truly there are three things which make a nation great and prosperous—a fertile soil, busy workshops, and easy conveyance for men and commodities from one place to another;" "to which," he says, "let me add knowledge and freedom."

Thus, following this idea, we ask your aid in restoring, for purposes of international intercommunication, the Continental connection of old time existing. For, doubtless, England and France were once one, by continuous surface; and the "silver streak" is but gradual erosion, at last yielding to navigation a channel of 20 miles wide, in its narrowest part, of 180 feet in its greatest depth, in that narrowest division between two countries whose white cliffs, alternately, smile, in a warm glow, on every sunny evening and morning, the English side bidding good morning to the French at sunrise, and the French saying good night to England at sunset,—all the year round.

Now, if this twenty miles were a sandy desert or a stagnant marsh, how long would it be left as a barrier against popular intercourse? If France and England were one country, how long would the sea-barrier remain untunneled? If France and England were in perpetual amity by reason of thorough mutual dependence, who would object to the Tunnel? Then here arises the radical difference. We, who accept your ideas, say that civilisation demands the approximation, the other side contend for the isolation, of the two nations.

Let us, therefore, for a moment, refer back to a point of history making this Society illustrious. In old time this Society occupied itself in devising plans for the extension of the commerce of our Empire. Since then it devoted itself to the industry of all the world. For on the 30th June, 1849, your then President—the ever-to-be-lamented Prince Consort—called a meeting of the Society of Arts at Buckingham Palace, and there developed his great idea of an International Exhibition of the works and products of all nations. Her gracious Majesty has written an account of the opening, in 1851, of that Exhibition. She gives in admirable words the soul itself of that great idea. She says:—

> "The sight as we came into the transept was magical—so vast, so glorious, so touching—one felt, as so many did to whom I have since spoken, filled with devotion." And she proceeds to say:—"The tremendous cheers, the immensity of the building, the exotic palms, the flowers, the trees, the statues, the fountains—the organ with 200 instruments and 600 voices—and my beloved husband the author of this *peace festival*, which *united the industry of all nations of the earth*—all this was moving indeed. It was and is a day to live for ever."

Following this idea, so inimitably clothed in our English language, we simply labour to make a permanent "peace festival:" and for ever to "unite the industry of all nations of the Earth"—with one heart utterance, "God save our Queen!"

We ask you to tell us if we delude ourselves when we say we are working on the same lines of progress?

But to turn back from this ray of light, shed over victory, bear with me, gentlemen, for a moment, when I point to the black darkness of prejudice—vulgar, selfish, ignorant—which gathered, pest-like, around the cradle of the International Exhibition. For herein we shall find a parallel.

Hear what your then President said. You will find it in Theodore Martin:—

> "The opponents of the Exhibition work with might and main to throw all the old women here into a panic, and to drive myself crazy. The strangers, they give out, are certain to commence a thorough revolution here, to murder Victoria and myself, and to proclaim the red republic in England: the plague is certain to ensue from the confluence of such vast multitudes, and to swallow up those whom the increased price of everything has not already swept away. For all this I am to be responsible, and against all this I have to make efficient provision."

And your then President adds, in a letter to Baron Stockmar:—

> "The Exhibition is now attacked furiously by the *Times*, and the House of Commons is going to drive us out of the park. There is immense excitement on the subject. If we are driven out of the park the work is done for."

(Let me here interpose a remark. We, men of the practicable Tunnel are not to be "driven out of" our experimental works by Parliament, for Parliament is kept, by the Government, from discussing the question.

A popular writer has recorded that Colonel Sibthorpe warned everybody—

> "To take care of their wives and daughters, of their property and their lives. That Lord Campbell opposed the Exhibition in the Lords, and that Lord Brougham in that 'other place' said—nay shouted—that all this showed that absolute prostration of the understanding which takes place, even in the minds of the bravest, when the word 'Prince' is mentioned in this country."

And the same writer goes on to say—

> "The Duke of Cambridge, being appealed to on the subject, acknowledged himself also full of apprehensions. The press was not, on the whole, very favourable to the project, and *Punch*, in particular, was hardly ever weary of making fun of it."

The Preface to the Illustrated Catalogue of the Exhibition of 1862 says:—

> "Public opinion, in its surly moods, accused the Exhibition promoters of giving up their country into the hands of invited savages. The memorable May-day of 1851 was looked forward to with dread by many honest people, who regarded it as the turning point in England's fate. They expected that London would be ravaged at will, and planted with many varieties of new diseases. The tomahawk was looked for in Hyde-park—the stiletto in Cheapside, and dirt, strange costumes and stranger manners everywhere.

Unmanageable crowds were pictured assembling in the chief thoroughfares to make the Exhibition a stalking horse for riot and plunder. Wild fears produced over-caution in the laying out of plans, and the police and army were concentrated as if for an internal war."

Gentlemen, why have I thus digressed? Simply to ask you to remember—when I come to deal with similar attacks upon the idea of a Tunnel—that prejudice is the child of ignorance and littleness, often spiced with envy, hatred, and all uncharitableness: that its course and end is always the same. Why when, in 1720, Lady Mary Wortley Montagu introduced the process of inoculation, having watched its effects in stopping small-pox in Turkey, "she had to encounter the pertinacious opposition of the medical profession, who rose against her almost to a man, predicting the most disastrous consequences." Sermons were preached against her. She was told "Thou shalt not tempt the Lord thy God," and that her work "tended to anticipate and banish Providence out of the world."

Now here, I ask, does anybody object to improving the passage of the Channel in some form? and if no one objects to that, then comes the question, what are the best forms? for we do not confine ourselves to one.

Will any one to-day justify an English Act of Parliament, of 180 years ago, which recited that trade with France was a "common nuisance," and actually prohibited it altogether?

Gentlemen, coloured on the charts on the wall, you will see depicted three routes across the Channel—the first is the original projection for which Messrs. Hawkshaw and Brunlees take credit. It extends from a point to the eastward of Sangatte to a point to the eastward of St. Margaret's Bay. It follows the line of the submarine cable; and looks as if it had been put on the chart with compass and ruler. The second is the scheme of the same gentlemen of the present session. It extends from Sangatte, westward of the original point of departure, be it observed, to Fan Hole, a considerable distance westward, again, of St. Margaret's Bay. It begins at Biggin-street, in Dover, and ends 115 feet above high-water mark on the coast. The third is a route, the final outcome of all experiences. It is to pass through the "old grey chalk," or "craie de Rouen," all the way from point to point. Subject to slight variations, affecting no scientific principle, it presents, in our opinion, the conditions under which a Tunnel can be made. Those conditions may be summed up as the existence of a continuous stratum impervious to water, and workable by machinery—without need of any pumping of moment, or of timbering, during construction.

On these conditions, we answer the first question, and say—the Tunnel can be made.

In contending that the geological limit through which this *tracé* proposes to pass, is the only possible Tunnel territory, I am ready to meet all comers. I hope those who seek to hide geological and engineering mistakes (admitted, to a large degree, by the change of point from St. Margaret's Bay to Fan Hole), by the proposal of "powerful pumping machinery," will to-night have the full courage of their opinions. I hope they will not deny the warnings we persistently gave them in 1874 and 1875. Let them be logical, and tell us that it is better, and cheaper, and speedier, to pump the sea and the land, one or both, than to avoid water altogether. Let them tell us how it is that they totally differ as to this vital question of the *tracé*, or route, from the eminent Frenchmen now engaged upon the Tunnel works in France? From 1874 to 1877, the French engineers made entirely new surveys and soundings, throwing overboard those of Hawkshaw and others, and they came to the unanimous conclusion that the St. Margaret's Bay site was wrong. M. Michel Chevalier, the eminent first President of the French Channel Tunnel Company—his post being now occupied by M. Léon Say, a man no less eminent as a political economist—and the present Ministre des Finances of the French Republic, wrote to me as follows, under date 29th May, 1877:—

> "The map showing the strata of the Channel is to be delivered to us by the printers, at the rate of 100 copies to-morrow, and 100 more the following day. I have given orders that a copy be sent to you immediately, likewise to Mr. Forbes, with the memoir of the engineers.
>
> "The line we prefer following under the Channel differs to some extent from that originally proposed by Sir John Hawkshaw; but lately, Sir John having had a conference with M. Lavalley, he seems ready to accept our general line, with unimportant changes.
>
> "In consequence of the adoption of our *tracé* even with a few changes, a great benefit for Folkestone would accrue. It is true that some Englishmen say, that your military engineers will require that the *exit* on the English side shall be under the guns of Dover by reason of national defence.
>
> "In such a case Folkestone might be deprived by force of that she was to obtain, but what may be exacted by the military engineers no one knows, and

some plan might be contrived to give satisfaction to Folkestone at all events."

And at an interview with M. Chevalier and M. Lavalley, on the 24th June, 1877, at the residence of M. Chevalier, these gentlemen submitted plans showing the various routes, and stated that they were now of opinion that it would be better to commence the works near Folkestone, on the English side, instead of at St. Margaret's Bay or Dover. They stated that over 7,672 soundings had been made, and that they had got over 3,253 specimens of chalk.

In reply to my inquiry, M. Lavalley stated that he had no doubt whatever from the experiments which had been made, that the work could be carried out successfully. They had spent £10,000 in making the experiments, and, so far as the people on the French side were concerned, they were now prepared to go into the matter with the authorities on the English side. But I ought here to quote the opinion of Mr. Topley (A.I.C.E. Geological Survey of England), dated Alnwick, 16th January, 1878, entitled "Report on the Recent French Explorations connected with the Channel Tunnel to the Chairman and Committee of the Channel Tunnel Company, Limited." He says, as his final conclusion :—

> "The direction always advocated by Sir J. Hawkshaw and Mr. Brunlees (from St. Margaret's Bay to near Sangatte) *still remains the best that can be proposed.*"

We ask, was M. Chevalier right in asserting that Sir John Hawkshaw had been convinced of the error of his previous *tracé*, and was prepared to adopt that of the French engineers —which is ours—as shown upon that map, subject to some slight—honour-saving—modifications, or was he not? We ask, further, has not a section showing eight *tracés* been prepared and shown to our friends across the water? Is not a copy to be seen in Paris; and is not the only *tracé*, thereon shown, entirely through non water-bearing material—our *tracé*—as shown, also, on that same map? If this be true, then what is the explanation?

As respects the narrow and shallow channel, I repeat that I beg you to keep before you a simple geological fact. It is this: Providence has kept open for the world a narrow slip of submarine territory, with impervious strata, workable by simple machinery, about 300 feet thick, suspended, as it were, between water and water—the sea above, the lower greensand, and other water-bearing beds, beneath; and through this bridge of material, and this alone, can a great highway for the nations be easily, cheaply, and expeditiously constructed.

This, largely, answers our second question —as to how the work can be done.

But on the geological questions involved, I trust our able colleague, Professor Boyd Dawkins, will favour the Society with some results of his recent observations.

The machinery by which we are doing the experimental work is depicted in the drawings on the wall. It is very ingenious, and therefore, very simple. If you know how to bore out a gun, you will easily comprehend the invention of Colonel Beaumont and Captain English. Its motive power is air compressed above ground; and this air, working up to 40-lbs. to the inch, through a 4-inch pipe, at once turns the machine, and ventilates the working. With this machine we have bored 100 yards of heading, 7 feet diamater in a week. We believe that, substituting a 12-inch for our 4-inch pipe, we could double the quantity of work. Another machine will enlarge the boring to 14 feet diameter. And we can line this full width of a single line Tunnel about as fast as we can bore it; and, obviously, a second single line Tunnel can go along, side by side, as fast as the first, with adequate energy and enterprise. Until a heading has been driven right across, from side to side, doubts and apprehensions will survive. And unless the Tunnel be so wicked a thing that its practicability ought to be kept in doubt for ever, I venture to urge that the sooner the popular mind has before it realised facts—thorough and complete—the better for science and for mankind.

On the question of time, I venture the opinion that such a driftway could be completed in two years, and that the whole work might be finished within five years. While on the question of cost, I prefer to hear some opinions here, for which I am waiting before giving my own calculations.

But ought the work to be done?

No one that I know of denies its vast utility, but objections are taken that it might endanger national security. Any danger, of any kind, as between England and France, must be similar, if not the same; any advantage must be mutual.

We are told that while the "silver streak" will ebb and flow over the Tunnel for all time, yet we abolish it. How so? The "streak" will remain. The sea will ever perform its grand function, as the path of commerce and of nations; the larger ships of modern trade will force the construction of deep-water harbours everywhere. For instance, between Cherbourg and Dunkirk inclusive, twelve ports only, £6,700,000, voted by the French Assembly since 1879, are being expended in the completion of about 3,000 acres in all of deep-water docks and harbour space. Has this over-balance of harbours, in the Channel, ever been thought of by any of our alarmists? England will have to provide twin accommodation on our side the Channel; and the Tunnel below the sea, will, on its completion, be the handmaid of great harbours of commerce at Dover, at Folkestone, and elsewhere. Trade makes trade. Facility begets facility; and, so far from interfering with the mercantile marine, the Tunnel, as a rapid and certain distributor of commodities without break of bulk from harbour to market, will perform the self-same function which railways everywhere have afforded to a commerce unparalleled in any previous age—a commerce gone to-morrow and for ever, if our railway system were finally obliterated. No, we contend that England is outgrowing the "streak," as it outgrew canals and roads; and we urge that our object supplies the want of to-day, the necessity of to-morrow, in the only way it can be supplied.

It has been well said that—

> "The creation of this great line of junction would put an end to the commercial isolation with which England will be threatened by the completion of the great railway system which will connect, without breaking bulk, the centre of Europe with the Western Ports of the Continent. The Submarine Tunnel, by placing the ports of England in regard to the commercial centres of Europe, in a state of continuity identical with that of the Continental ports, will permit England to sustain with advantage the competition which will be created by the junction of the Ports of the West of the Continent with the Centre of Europe, by means of the railways in course of execution. The commercial necessity of uniting the English railways with those of the Continent, appears then to be in reality the determining consideration which should prevail with the statesmen and economists of England; a leading question, in fact, and one upon upon which British genius has from the first laid its finger."

But let me ask, is our great manufacturing and trading country, is our crowded population to be always dependent upon the sea alone, for its intercourse, its trade, its supplies—nay, the very bread we eat? Were it impossible to supplement the sea, by bridging its narrow arms, we should submit to the inevitable; and, in that case, we could easily calculate the limits of our growth, and foresee the tenure on which we must consent to live—on the sufferance of other nations. What would be our position, if, by combination of powers against us, and even with France, a neutral, we lost for any period, more or less lengthened, the mastery of the seas? That is not impossible. Certainly it is more likely, at all events, than the surprise of the Tunnel mouth by a thousand Frenchmen disguised as tourists. We insist, therefore, that here we point out the one grand danger to our country; and that we offer the only possible remedy. Let us hear the answer. We may be told that there is no danger of the loss of naval supremacy. But what do our leading lights tell us? The *Pall Mall Gazette*, a day or two ago, in writing about the flagship, the *Minotaur*, in no complimentary language, said of the fleet which protects the "streak:"—

> "Judging from the other ships that during these last months have constituted the Channel Fleet, it would seem that this 'squadron' is considered a hospital for incurables, or a sort of dustbin, rather than, as is frequently urged, it ought to be, distinctly the school of naval tactics and evolutionary science."

Sir William Armstrong, one of the opponents of the Tunnel, whose late partner is the new Civil Lord of the Admiralty, publicly says, "Our Navy is at present armed with guns which could not be expected to contend successfully with the best modern guns that could be used against them." Yet surely the gun is the initial question of modern naval warfare. Sir Thomas Brassey, a member of the Government, tells us the reason of these shortcomings. He says, "It is somewhat discouraging" (more than "somewhat" I should say) "to observe that all the improvements recently introduced into ordnance are due to the inventive skill of private manufacturers. There are influences at work in the public service which tend to discourage invention. No motive power exists leading men out of the beaten track."

If we want to realise, in some faint degree, the confusion and disaster the blockading of our coasts by hostile fleets, in the absence of all under-sea outlet, would bring on, we have merely to remember what happened to our cotton industry in the late civil war of the United States. Half-a-dozen cotton ports in the Southern States were blockaded by the Navy of the North. We had at once a cotton famine in England. Cotton rose in prices from 6d. to 3s. a pound. A million and a half of men, women, and children were thrown out of work, and had to be fed by public work and by charity. Every commercial relation was unhinged for nearly four years. Yet this was not a thousandth part of what would happen if we lost our power on the sea, and had the sea alone to depend upon for our food and manufacturing supplies.

I finally, on this head, put this question: if England has command of the Channel, how could the Tunnel, defendible from the Channel, and from the land, be taken, assuming it not to be destroyed? If England lost the command of the Channel, what could prevent invasion at any one, or all, of a score of points, where men could land and debouch under the easiest, instead of, as at the Tunnel mouths, the most difficult, conditions?

But the Tunnel works are so designed that they could be instantaneously disabled in one or all of a dozen varied ways—and under that condition, the Tunnel ceases and the alleged danger with it. The contention of Sir Garnet Wolseley is this—at some sudden moment, without any warning, any notice, any declaration of war, the Channel will be unguarded, the commanders at Dover and other strongholds will be traitors, the soldiers will be either asleep, or parties to the treachery, and 2,000 Frenchmen—soldiers in disguise—will steal through the Tunnel, and effect a lodgment on English soil. They will hold the Tunnel mouth, and train after train of the enemy will follow, land, march irresistible to London, and England, in twenty-four hours, will capitulate. Then, amidst other discomfiture, the robbing of the Bank of England, the seizure of Buckingham Palace and the Zoological Gardens—the Tunnel itself will be sequestered as part of our temporary ransom, so as to enable the French to invade England again and again.

Sir Garnet Wolseley does not, perhaps, remember that in the darkest days of the Indian Mutiny English troops were passed through France, amidst the sympathy of all Frenchmen, to save the empire. Why should it not be made possible some day to convey by railway both men of war and of peace to and from any part of our island to India? And, if that was done, how long would a break of twenty miles of sea endure?

Now, perhaps, I may answer this, so far as it affects our project, by reading a draft of the private memorandum which some eminent military men have favoured me with. They say:—

"The South Eastern Approach Railway begins by a junction with the existing line in Folkestone Warren, which is a strong defensible position; it is shut off from the main land on three sides by heights of great altitude, and the shore, which forms the fourth side, is inaccessible at high water, and is open to the guns of the fleet. The South Eastern Railway runs through the Warren for a considerable distance westward of the proposed junction in a perfectly straight line, and both it and the Tunnel entrance can be raked by guns placed on the Warren Cliffs. Mines also can be laid for blocking up readily the approaches or for destroying this entrance. It is most improbable that any attempt would ever be made to attack the Tunnel at this point, but should one be successfully delivered before these mines could be exploded, the enemy would be in possession of the entrance only, the key to the Tunnel being situated three miles therefrom, and a few yards to the eastward of the Shakespeare Tunnel" (that is what we call No. 3 Shaft). "Here the machinery for pumping and ventilating the Tunnel will, according to the Submarine Company's plan, be placed on the surface of the ground, communicating by a shaft and a cross-heading with the Tunnel. It will be within easy range of the Dover fortifications, and in full view of the guns. In this position, the machinery could be stopped at any moment, even if in the hands of an enemy, by a shot from one of the batteries. Arrangements would also be made for the construction of mining chambers in suitable proximity to the shaft and Tunnel, either for blocking it up, or for flooding it, or for both. These chambers would be reached by galleries communicating from the interior of the Dover defences, and the requisite provision would be made for exploding the mines by electricity at any moment considered necessary. The experimental heading has already proved that if no serious faults are met with under the Channel, a Tunnel can be driven rapidly and cheaply from shore to shore. This encourages the French Company to persevere with the work which they commenced in 1876 on the faith of the Convention between the French and English Governments. There is nothing to prevent this work being extended from the French to the English coast, even under the three-mile limit; for it would be impossible to tell without counter-mining what point the Tunnel had reached, or what direction it was taking. Under these circumstances it is best, even in a military sense, to meet the French half-way, and keep control on the English side of a work which might otherwise at some future time be used to our disadvantage. With respect to the objection that a sumbmarine tunnel might be used by an enemy, if not for the purpose of invasion, at any rate to secure his communications after effecting a lodgment on the coast, it may be remarked that the works in connection with the Tunnel would be as readily destroyed from the sea as from the land, and that so long as the naval supremacy of this country is maintained, no expedition would be attempted on the mere chance of securing such a precarious communication. Should England's supremacy at sea be lost, it would be an easy matter to land troops at any unprotected point along the coast; there would be no occasion to select our most carefully defended post for a first attack, but there is every reason to believe that the Tunnel could be as quickly and thoroughly destroyed as to be rendered utterly useless to the enemy."

As respects the history of the Tunnel idea, I may add that almost everything predicted, and a great deal of that discovered, with regard to the Channel Tunnel, is French and French only. The first record we find about a proposition to pierce a tunnel is in the days of the first Consul. A Frenchman, M. Mathieu, proposed to the First Consul—the Great Napoleon as he was called—to make a tunnel under the Channel for connecting England and France. Whether he intended it as a work of war or peace I do not know, but I am bound to say that, in the then state of what we may call submarine geology, it was a very capable plan. It consisted practically of two galleries. One was to be used for drainage purposes, the other for the roadway. There were no railways in those days, and his proposal was that the traffic should be worked by relays of horses, which would gallop through the tunnel in about an hour.

Following M. Mathieu, another Frenchman, Dr. Payerne, proposed to connect the Continent and England by a colossal bridge. Then MM. Franchot and Tessié proposed to lay on the bed of the Channel an iron tube. Then a ferry between Blancnez and the South Foreland was suggested in 1837: the two sides of the Channel were to be made to approach by works of masonry, and the narrowed channel was to be crossed by huge ships. Later on, that most able engineer, the late Mr. Joseph Locke, improved upon this idea. From time to time English engineers have built upon these ideas. Mr. Bateman proposed a tube. Mr. Fowler proposed a ferry which should take over whole trains. And Mr. Low, Mr. Brunlees and Mr. Hawkshaw have, in one fashion or another, tried to work out the original idea of M. Mathieu.

M. Thomé de Gamond became an enthusiast upon this question; and, in my humble judgment, M. de Gamond ought to be looked upon as the father of the more modern enterprise. If there ever is a tunnel between England and the Continent, and of the probability of it I for one speak, as far as my lights go, in the most sanguine and positive terms; then I say, the man to whom the great credit ought to be given is that enterprising and far-sighted Frenchman. He is dead. But, gentlemen, dead or living, you and I would not rob him of one atom of his fame. He worked, "mente, corde, manu."

Diplomacy on each side of the Channel has ratified the enterprise. Neither France nor England can back out.

In 1871 and 1872 a Liberal Government expressed to the Government of France its high appreciation of the utility of the work. On 24th December, 1874, Lord Derby, the then Foreign Minister of a Conservative Government, said, in a formal despatch—

> "Of the utility of the work in question, if successfully carried out, there appears no reason for any doubt, and her Majesty's Government would, therefore, offer no opposition to it, provided they were not asked for any gift, or loan, or guarantee in connection therewith."

The late Lord Derby left a record of his own views, to the same effect, in a letter to his concurring colleague, Lord Beaconsfield, then Mr. Disraeli. Three Prime Ministers, one living, two dead, favoured the work. Two Foreign Ministers, one living, the other (Lord Clarendon) dead, did the same. They all believed that the tendency of nations was, and ought to be, forwards, towards union, not backwards, towards isolation. Cobden said, I consider the Submarine Tunnel "the true arch of alliance between the two countries"—meaning England and France. The great Prince Consort foresaw all the advantages for England to flow from the creation of such a road to the Continent, all the dangers the want of it would accumulate round our country.

This, gentlemen, is—in feeble language I admit—the outline of the case. It is for you to say—whether our experimental works ought to proceed in peace, without cost to our country, but for her benefit.

DISCUSSION.

Professor **BOYD DAWKINS**, F.R.S., said he was in a position of extreme difficulty in having to make a few remarks upon what was generally considered a very dry subject, viz., upon the geological aspects of anything whatever, but he thought that the interest which attached to the Tunnel was an interest which would over-ride anything that might be dry in what he was able to put before the meeting. In the few remarks which he should make, he was merely speaking as a geologist; he was not one of those who wished to sign a petition to say that he was afraid of his country, nor, on the other hand, was he one of those who thought it right to sign a petition to say that he was not afraid. He was present to speak of the rocks to be met with if a tunnel was to be made between England and France. In order to make his remarks tolerably clear, he would ask those present to follow him upon the maps, where lines had been drawn to represent the different rocks. The lines represented different sorts of rocks, and the red colour represented a clayey material, known by the name of gault, under the chalk, which was impervious to water, and formed part of the sandwich, to which Sir Edward Watkin had referred. The impervious rock was to be found above the gault, that is to say, the green clay, which was erroneously called greensand, for it was not a sand at all, but merely a mixture of clay and sand, and was, for the most part, impervious to water. Above that, the light green colour represented a material known as grey chalk, which was something like 250 feet in thickness upon this side. Above that was a layer which formed the upper part of the sandwich, that is to say, chalk which corresponded in their ordinary idea of chalk, a white material like a sponge full of water. If these strata were examined, it would be found that they were perfectly continuous right away across until they arrived at the opposite side of the Channel in France. It was only last week that he had an opportunity of examining the rocks with very considerable detail in France, and to his great astonishment he found that he could almost identify, bed for bed, and foot for foot, the series of lower impervious beds of grey chalk—the lower chalk about which it was their interest now to inquire in connection with the Tunnel—for he might say that, with regard to the upper chalk, it was altogether beside the question. They were in possession of two series of facts. They could compare the line of section on the English side with the line of section on the French side, and they could see that they were perfectly continuous; besides which, the researches to which Sir Edward Watkin had drawn attention, pointed conclusively to the fact that these rocks corresponded the whole distance across the Channel. With those facts before them, they could not have any doubt as to the continuity of the beds right across the Channel. Now, it had been objected to the scheme that in all probability there were some great lines of dislocation, and he thought, in approaching the polnt in that fashion, the very erroneous idea had been entertained that valleys were merely great lines of marshes caused by the exertion of subterranean forces from below; he thought that was dead against what they knew about the history of valleys in the present day. Valleys were formed by the rain and rivers, and the ice and snow of preceding periods, and the great area which was now submerged, and constituted the Channel, was nothing but an ancient valley which was formerly excavated when the area was dry land, so that really, when they were dealing with the problem of the continuity of the chalk underneath the Channel, they were dealing with the probability of the continuity of chalk from one side of the valley to the other. He believed that in very early days the primeval hunter was in the habit of following the chase across the Straits of Dover, and would have been able to invade France by walking across where was now the silver streak. It might be said that there were lines of fault existing in between, which were likely to intersect the lines of enterprise. It was perfectly true there were lines of fault pretty nearly everywhere on the chalk bed; but what did they find when they examined the faults? They found that they were small and insignificant, the largest not having a larger dislocation than something like 25 feet. So far as his experience went, although fractures might afford free access to water in the upper beds, or even in the upper parts of the grey chalk, when they got lower down into the place where the tunnel was to be put, there they found that the beds were for the most part impervious to water. But in all these things, if he might say so, the proof of the pudding was in the eating; and when he mentioned that in the heading which had been driven they met with no water at all, he thought that fact showed or proved that in all probability the heading would be free from water all the way through. So much for that part of the question. The next thing to be considered was the exact position in which it might, perhaps, be considered best to make this line of tunnel, to drive the experimental tunnel, and he thought that when that section was looked at, it would be seen that the green layer extended right down, and that the red line followed the green, so as to give an impervious series of beds; and upon the French side, there being the same thing, he did say that getting into these impervious beds of grey chalk and sticking to them, was to his mind the only satisfactory and proper place for a tunnel to lie. So much for the general advisability from a geological point of view. The objections which occurred to him in relation to one of these routes—the route, for instance, which was marked upon the map through the yellow bed, were of very great value, and very serious indeed. In the first place, the works would run through the water-bearing upper chalk, and if the pumps were capable of beating back the water, and draining the work, then there was a considerable probability of their draining the area of Dover. Supposing they could do that in the experimental borings, it was certain they would meet with a greater obstacle when they got under the sea. In driving a heading through the upper chalk, there was every reason to suppose that engineers would be obliged to draw, not only upon the fresh water streams, but they would also, when they conquered them, have to battle with the ingress of the sea; and, therefore, it seemed to him that of the two schemes, there was only one which recommended itself to their common sense, and that was the scheme which began in the green impervious beds, remained in them, and emerged on the French side in those same beds. There was one other point which he should like to mention. The experiment was not merely valuable as an engineering experiment, but exceedingly valuable as a scientific experiment. It would be an interesting thing to know the exact situation of the rocks under the Channel. Further than that, Sir Edward had undertaken to carry on some deep borings which would reveal more than the constitution of the chalk rocks; he had undertaken to carry out a series of borings which, to his mind, would very likely prove of great national importance. It was well known that on the side of France and Belgium, emerging from underneath the chalk, had been found large and valuable coal beds; and many scientific persons had been looking for these beds in the neighbourhood of Hastings. He need hardly remind them that some few years back an experimental boring was made at Battle, which was carried to a depth of 1,900 feet, and in a boring to be carried on further north, they were likely to hit upon this coal-bearing rock. He thought there was no doubt they would hit upon the ancient line of rocks, even if they did not hit upon the actual rocks themselves, and they would afford a point of observation by which people in future ages would be able to gradually go on working through the newer rocks, and ultimately arrive at the coal measures which, beyond a doubt, underlaid the south eastern part of England.

Mr. TYLDEN WRIGHT said the last speaker had dwelt upon the probability of finding coal near London, but he, unfortunately, was a mining engineer connected with collieries, who had looked to London for a market, and if the prognostications of Mr. Dawkins were carried out, his occupation would be gone. He had been connected with collieries in the Midland Counties for twenty-five years, in which it had been necessary to pay attention to underground haulage, to ventilation, and to winding, and after seeing the wonderful work which Colonel Beaumont's machine could do, steadily advancing 17 yards every day, in this work, he felt that there would be no difficulty, as the newspapers seemed to suppose, in dealing with the quantity of *débris* which the machine would turn out. It simply meant an outlay of £520, and that for working twenty hours in the day would mean only twenty-six tons an hour. That was about one-fourth of what any large colliery passed along its underground roads in a day. The cost of such a haulage in any large colliery did not exceed one penny per ton per mile for all the coal drawn along. The cost in this case would be fourpence per ton per mile, so that the whole cost of drawing it right through the 22 miles would not exceed £20,000. The permanent ventilation of the Tunnel must depend upon what system of haulage was ultimately adopted, and the only possible system which he thought could be carried out without difficulty would be that of compressed air. To his knowledge, compressed air had been used at the bottom of a shaft for over 10 years, to draw 1,000 yards without a single hitch, and therefore he did not see the slightest difficulty in its being applied to locomotives drawing trains through the Tunnel. In that case, the train would almost provide the quantity of fresh air requisite, but if not, it would only require an engine of 200-horse power to do it, which could be supplied at a very small cost. As far as the ventilation and haulage were concerned, he felt that the difficulties were chimerical, and need not be entertained for a moment.

The CHAIRMAN said the question was one upon which a great deal of controversy had arisen, and therefore he thought it fair that both sides should be heard. As they were favoured that night with the presence of Lord Dunsany, the writer of an able article in the *Nineteenth Century*, he would ask his Lordship to favour the meeting with his views upon the subject.

Lord DUNSANY said he was in the position of the Devil's advocate, as he was at a meeting of progressional people, and yet he belonged to the "stupid party," who were decidedly opposed to the Tunnel. Of course he would give his reasons for opposing the project; but, as a preliminary remark, he might say that the gentlemen with whom he acted were rather against entering into details at present. They said it was a great question of principle, and that they were not now going to be led away by little matters of detail, matters which might show that the scheme was more or less practicable, which might prove that certain fears were more or less groundless, or that a considerable advantage would arise from making the Tunnel. But the primary and important question was what were you going to deal with now. Their territory had been for 800 years inviolate, but could any one in that room suggest that there was any better reason than the silver streak for the territory having been inviolate. He could not quote from ancient or modern history one single instance of a country where the inhabitants could look upon their shores, and say that on those shores, for 800 years, no enemy had set his foot. That was so all-important a question that everything else sank into insignificance. Having said that, he would further protest against one remark which Sir Edward Watkin had made when he asserted that what had been already done, whether by this or that Minister, had, in fact, committed the country to the enterprise. As an Englishman, he denied that any Minister, whether the Prime Minister or Foreign Minister, could commit him or those who came after him, to so serious a risk as some people said was involved in this Tunnel. For his own part he confessed that if he felt any alarm about the scheme before, certain remarks of Sir Edward Watkin, which were intended rather to dissipate that alarm, had confirmed his fears. Sir Edward said that by and bye certain enormous deep-water harbours would be constructed within sight of their shores, and that they would be of such capacity that they would harbour any number of French ships. He also said we had nothing on our side where we could harbour an English ship. Now, he naturally asked himself why were their excellent neighbours building these enormous harbours? Colonel Beaumont, after referring to the enormous harbours which would shortly be built, by way of reassurance, said they were on such an enormous scale that they could not be intended for commerce, and that they were not intended for war. If so, he should like to know what was the foundation of these harbours. After puzzling his brain for some time, all he could think of was that they were for French ladies to bathe in. Sir Edward Watkin also said that the Tunnel would not be a source of danger, but a tie of perpetual friendship—a security for perpetual peace. But if one little road of 7 ft. wide would secure perpetual peace, how on earth was it that France and Germany, with many and wider roads between, ever came to fighting? Sir Edward had also referred to the objections raised to the Exhibition of 1851 by persons who were frightened of this, and the danger which might arise, and, although he (Lord Dunsany) did not remember whether he indulged in those prophecies, he was quite willing to say that he did, provided he might retort upon the gentlemen upon the other side, who prophesied that the Exhibition would be the means of bringing about the millennium; and when Mr. Armstrong, Mr. Lancaster, and some other old-fashioned people wished to exhibit their manufactures, they were told to take their antediluvian things away, because they were not going to have any more wars. That was in 1851; but in 1854 they were hammer and tongs at it. Four years passed away, and then what did they see? Why, another desperate war, when France marched into Italy, and fought two great battles. Were those the only two interruptions to the millennium? If his memory did not deceive him, they had a war in the north of Europe, and shortly afterwards there was a greater fight in Central Europe; and everyone would recollect the war of Sadowa. Did that end it? Very far from it. After inaugurating the millennium, they seemed to have kept the ball rolling constantly since; but now they were told that the Tunnel was to be the remedy for all evils. For his own part, he could not say that he felt any confidence at all upon the point. There was one remark made by Sir Edward, which seemed to be original. He said, supposing they lost the command of the sea, and their ships were blockaded, they would see what use the Tunnel would be in supplying England with food. Now, he should say that was the strongest argument that could be used against the Tunnel, because the greatest misfortune that could possibly befall this country would be when she ceased to depend upon her navy, and looked to the Tunnel for her security. If the danger was losing the command of the sea, then the more shame for themselves. Those who had the misfortune to be as old as himself would recollect there was a considerable scare about a possible invasion some time ago, and great authorities were consulted as to the proper measures which should be taken; amongst others, a great financial authority was consulted as to what would be the actual effect upon the social economy of the country by the occupation of London, and the answer given was, "You must not think of it." That answer meant this, that the thing should be made impossible; and that answer, he thought, applied to the case of their naval supremacy, for whenever they lost that, they deserved to lose it. Speaking of the construction of large harbours recalled to his mind the fact that the French were building a huge fleet, and he did not see why England should not construct a navy equal to any two Powers that could possibly attack her. As they were upon the question of the Tunnel, he really thought that they should not lose sight of the fact that they did not possess the navy which everyone believed they did, and which everyone agreed they ought to have. Many people in the room, no doubt, had read a little pamphlet called "Forewarned, Forearmed," written by Lord Henry Lennox, which went into details, in order to prove that our fleet was barely equal to the French, and would in a few years be inferior. There was also a most valuable book written by Sir Thomas Brassey, and its effect was not more re-assuring than Lord Henry Lennox's, because it also admitted that the navy was not what it ought to be. Under these circumstances he, for one, did not think that the time had actually come to play with the insular security which had served them for 800 years. The time might come, but it ought to be a matter for international decision, and not for enterprising individuals, however valuable their services might be in the matter of railway travelling. He did not believe that the growth of wealth meant a growth in pacific disposition. He saw just as many symptoms the other way, and when he remembered that England was the richest country in the whole world, and the only country which had no conscription, he thought the present time was not particularly opportune for establishing the Channel Tunnel, as it was called, but which in military parlance would be called a covered way by which an enemy could advance in perfect security. They were told that certain securities would be adopted, such as letting the water in, and the idea of pumping this water out had been very much ridiculed by Sir Edward Watkin. Colonel Beaumont told them that the Tunnel could be flooded by two or three six-inch pipes, and no doubt it could be, but it would take some time. Supposing it could be done in a day, it followed with mathematical certainty that with six six-inch tubes worked by adequate horse power it could be pumped dry. Then they were told that there would be dynamite mines which would blow in the sides of the Tunnel; that might be so, but he held in his hand the opinion from an expert on the subject, Mr. E. A. Cowper, past president of the Institution of Mechanical Engineers, who said he had attempted to design an arrangement by which the Tunnel might be made safe by being stopped or flooded, or blown up in an instant, if necessary; but he confessed he was not in any way successful in his attempts. Of course he did not pretend to say whether Mr. Cowper was right or not. It was all very well to say that you should have sufficient means of protection, and they ought not to break down, but experience showed that that was exactly what did happen. Sir Edward Watkin had mentioned the case of the tunnels in the Vosges; they were all mined according to the Prussian authorities, but none of them were fired. He might mention one case which was historical, the occasion when England, a strong power, attacked Denmark, a small power, in a time of peace, and took away her fleet. Such things had happened, and had been defended diplomatically, and might occur again. The object of England then was to carry off the Danish fleet, which would otherwise have been employed by Napoleon against England. We did carry off the fleet, and all the ships were found, in nautical phrase, scuttled; they had holes cut in their bottoms, which were simply plugged with temporary plugs, which could have been pulled out in a moment; but when the moment came to pull the plugs out, they were quite forgotten. These things always happened in that way. An article had been referred to which had been generally attributed to Sir Garnet Wolseley, who had not denied the authorship; but whether he wrote it or not, he (Lord Dunsany) was n a position to say that it accurately represented Sir Garnet's sentiments on this question.

Lord BRABOURNE said he came to listen and learn, not to speak, but having been asked to say a few words in reply to his noble friend who had just sat down, he could not refuse to do so. However he might differ from what he had said, the eminence of his position, the high character he bore, and the motives which actuated him, entitled him, at least, to his sincere respect, although he could not give to Lord Dunsany's arguments the weight which, no doubt, he would desire. There was nothing so difficult to deal with in this world as a patriot. Patriots, however, sometimes made mistakes. He had known patriots who persisted in conspiring for the sake of their country at the most unfortunate time for the country; others who insisted on plunging their country into war at the most unfortunate moment; and he had heard of others, who thought it necessary to stab some individual who they thought was injuring their country, but who really was endeavouring to benefit it. But the man who stabbed an individual, was, after all, only a degree removed from the man who assassinated an idea, and, to his mind, it was most unfortunate that a great number of patriots at the present moment were endeavouring to assassinate an idea which, for his own part, he believed would, in the long run, be found to be conducive to the development of the resources of our country, and the improvement of her position. His noble friend had asked the question, what except the silver streak had caused the inviolability of our country in times past. Until very recently he should have said there was something, and even now he should say there was something else—the knowledge which foreign nations had always possessed of the character of Englishmen, that they would not submit to the invasion of a foreign country, that they were able to hold their own against all comers, and that, silver streak or not, England would always be an independent nation. He was able to see that this question now occupied a very different position to what it did but a few years ago. Firstthey were told that no Channel Tunnel could possibly be made; that standpoint of opposition had gone, and people now owned that it had been shown that a tunnel under the Channel was practicable. The next thing they were told, and not very long ago, when this outcry first arose against the Tunnel, was that England could be easily invaded; that cry was passing away, and if one looked at the arguments used against the construction of the Tunnel, founded on the advice of certain admirals and generals, they did not now affirm that England would be invaded through the Tunnel. The arguments closely reasoned out had shown them that it was next to impossible that invasion could take place through the Tunnel, and that no military commander who knew his duty would trust his men in that narrow tunnel to invade this country. Their opponents had now fallen back on another line of argument, and they said if once an enemy had got his hand on England, then he would be able to get his supplies through the Tunnel so much more easily than he otherwise could do, and that was the real danger. But what did that come to? Before an enemy got into possession of English territory, we must have lost the command of the Channel.

Lord DUNSANY—For the moment.

Lord BRABOURNE said it must be a long moment; the enemy must be in perpetual command of the Tunnel. What position would the enemy be in? Suppose him to overcome the little obstacles which might be interposed by those Englishmen who still had some valour left, and who defended their country; if he had possession of the country he would be constantly on the look out, knowing that at any time he might be deprived of the command of the tunnel, that the Tunnel might be destroyed, so that the enemy's position would be very little better with the Tunnel than it was now without it. It was now generally admitted that the Channel was never likely to be used for the purpose of invasion, and if that was so, and the use of the Tunnel to an invader simply came to a question whether he could get supplies through it or not, then it still depended on the command of the Tunnel; the moment England got command of the Tunnel again where would the enemy be? It was, however, a very painful aspect of the question to take, to argue on the probability of a war occurring between this country and France. He was one of those who believed that the nearer you brought nations into contiguity, the more you made them understand each other, the less likelihood there was of war. In his early life he remembered the great prejudice which existed in the upper and middle classes of this country against Frenchmen; when Englishmen talked of Frenchmen as if they were their natural enemies; but one did not hear this now-a-days. Why not? because steam communication had enabled the upper and middle classes of Englishmen and Frenchmen to become so much better acquainted with each other that national jealousy had faded away to a great extent; they understood each other, and were beginning to know that it was their interest to be friends, and not to be enemies. If facilities of communication were increased, and the people of the two countries were brought more into contact, that feeling would permeate every class of the population. He believed that the more Englishmen and Frenchmen understood each other, the more they would come to see that past wars had all been mistakes, and that they originated generally in personal jealousies, the ambition of some ruler, or the desire of some dynasty to strengthen itself; that the real feeling of the people at large had always been for peace, and that that would be so more and more as they understood each other better. One might argue on this question to all eternity, and he should not expect to convince those who were of a contrary opinion; for Englishmen did not like to be convinced; but he would remind gentlemen that there was, at this moment sitting, a committee of important military men to consider this question, and before pronouncing a decided opinion upon it, it would be as well to hear whether their advice coincided with the views of Lord Dunsany, or with the views which he had ventured to express. For his own part, he had always seen in this Tunnel great good likely to arise, not only to England and France, but to the cause of humanity in general. He might be wrong, but he did believe in Christian principles; he believed in the Christian religion, and that Christianity taught us that nations should learn to love and respect each other, and that we promoted the first principles of Christianity, when we tried to bring nations into closer contact with each other. He said this with diffidence, and he had the greatest respect for those who differed from him, but he believed the truest patriotism was that which did not seek to isolate itself from the rest of mankind, but tried to impart to the other nations of the world the institutions, the freedom, and the blessings which we ourselves enjoyed. He had confidence in English institutions, and English spirit, and he believed that the more we mixed up with our neighbours, the more likely we were to do good—far more likely than to get harm from them. At any rate, that was the views of those who promoted the Channel Tunnel. For himself, he had a very small pecuniary interest in it, and would not have associated himself with the enterprise but for the feeling that he believed it to be a work of great international good. He had seen and heard in times past of many movements which had met with the like opposition. He remembered, when steamers were first put on the Channel, a great deal was heard about the mischief that was going to happen; how England would be invaded in half-a-dozen places at once, and we should not know where the enemy would land. Now, the exactly opposite view was taken, and it was said, here is the exact spot where you must expect an invasion. Everything which was brought forward to improve mankind, or to develop the resources of a nation, always met with opposition—honest opposition, made by people who thought they were very well off as they were, and did not want to run the risk of being worse. Again and again he had seen these improvements bitterly opposed, then adopted, and the very men who had opposed them had wondered, afterwards, at their own opposition; and so, he held, it would be with this Tunnel. There would, no doubt, be many discussions over it, and he hoped they would all be conducted in an amicable spirit, because he was sure they all desired the good of their country. He should be the last man to impute to those who differed from him any other feeling, but believing, as he did, that this was a measure of progressive improvement which would advantage England, enlarge the area of civilisation, and develop the resources of this and other countries, and tend to bring nations more closely together, and promote the great cause of peace and goodwill amongst mankind, he could not hesitate to say, in spite of the fears of his noble friend, so far as an admiral could entertain fears, that he believed the time would come when this would be accomplished, and he hoped sincerely that his noble friend would live many years after it had come, and look back with regret on his present opposition. He thought this was one of the noblest feats of the age, which deserved the support of all Englishmen.

Admiral Sir JOHN D. HAY, F.R.S., Bart., begged to offer his support to what had fallen from Lord Dunsany. Lord Brabourne had stigmatised them as patriots, and they did not at all demur to the charge. Now they believed the side they took on this great controversy was the patriotic side; and if he might be permitted, he should like to express a few words supplemental to what had fallen from his gallant friend Lord Dunsany, especially with regard to one thing advanced by Lord Brabourne. What Lord Brabourne said was quite correct in reference to the number of ships we possessed in comparison with France. It was quite true that France would have 56 ships, and we 58, in the course of the next two or three years, but at the present moment we were about equal. In former days, when our fleet was very much larger than that of France, when we had double the number of ships of France and Spain united, or nearly so, in the critical operations at Trafalgar, we were only able to muster 27 to contend with 33, because our distant dependencies and our Colonies, which were now much larger and more important than they were then, required the services of a great proportion of the fleet. It was therefore not at all impossible that for a short time the Channel might be in possession of a hostile fleet; during that time it was not at all impossible that our shores might be invaded. He demurred to what Lord Dunsany said about our shores being invaded. Our shores might be invaded by a hostile force; such things had happened as an invasion of England at least eight times since the Norman conquest. The question now with the great generals who had questioned the possibility of an invasion of England, was not the possibility of landing an army here—the difficulty was to supply the army when here, and to get it away again, and the Channel Tunnel would, in his opinion, supply the very want they required. Suppose the enemy's force was landed, and the fleet was led away, as Lord Nelson's was, to the West Indies, or to the Mediterranean, or to some other land, on return it would cut off the supplies to the invading armies. Suppose the army were landed in Kent, on the Essex marshes, or any part of the country. At present, there being no Channel Tunnel, the enemy's source of supplies would be cut off by the return of the Channel fleet; and though there would be great destruction of property and loss, the invading army would be destroyed. But given the Channel Tunnel, though our fleet might be in possession of the Straits of Dover, underneath the keels of the fleet would be coming the supplies for the hostile army, enabling it to carry on its operations. That was the point he desired to put to meet the arguments of his friend Lord Brabourne. He must say that if anything could have persuaded him, it would have been the eloquent speech of Sir Edward Watkin, but he was not yet persuaded. He had pointed to this magnificent bed of grey chalk as a gift of Providence, but Providence sometimes gave gifts which were temptations to men to do wrong; and if this unfortunate gift were accepted in the spirit of Sir Edward Watkin, he very much feared the country would suffer for generations to come, as the human race was now suffering from the temptation which Providence offered it in Eve's apple. He was strenuously opposed to the proposition; he had no right to question the engineering or geological details, but with regard to the naval defence of this country, he entirely concurred in what had fallen from Lord Dunsany, and trusted his remarks would not be inopportune.

The CHAIRMAN then said the hour had arrived when it was usual to close the discussion, and though he had no desire to apply the clotûre on this occasion, he suggested that it might be as well to adjourn the discussion. This was unanimously agreed to by the meeting, and the discussion was therefore adjourned to Monday evening next, at 8 o'clock.

Miscellaneous.

BRITISH ASSOCIATION.

The arrangements for the fifty-second meeting of the British Association, to be held at Southampton, are as follows:—

The first meeting of the General Committee will be held on Wednesday, August 23, at 1 p.m., for the election of the President and sectional officers, and the despatch of business usually brought before that body. The General Committee will meet again on Monday, August 28, at 3 p.m., for the purpose of appointing officers for 1883, and of deciding on the place of meeting in 1884. The concluding meeting of this Committee will be held on Wednesday, August 30, at 1 p.m., when the report of the Committee of Recommendations will be received.

The first general meeting will be held on Wednesday, August 23, at 8 p.m. precisely, when Sir John Lubbock, Bart., M.P., F.R.S., will resign the chair, and Dr. C. W. Siemens, F.R.S., president elect, will assume the presidency, and deliver an address. On Thursday evening, August 24, at 8 p.m., a Soirée; on Friday evening, August 25, at 8.30 p.m., "A Discourse on the Waves of the Sea," by Mr. C. W. Merrifield, F.R.S.; on Monday evening, August 28, at 8.30 p.m., "A Discourse on Pelagic Life," by Prof. H. N. Moseley, F.R.S.; on Tuesday evening, August 29, at 8 p.m., a Soirée; on Wednesday, August 30, the concluding General Meeting will be held at 2.30 p.m.

The following is a list of the sectional officers:—

A.—*Mathematical and Physical Science.*—President, Lord Rayleigh, M.A., F.R.S.—Secretaries, W. M. Hicks, M.A.; Professor O. J. Lodge, D.Sc.; D. McAlister, M.A., M.B., B.Sc. (Recorder); Rev. G. Richardson, M.A.

B.—*Chemical Science.*—President, Professor G. D. Liveing, M.A., F.R.S.—Secretaries, P. Phillips Bedson, D.Sc. (Recorder); H. B. Dixon, M.A., F.C.S.; J. L. Notter, B.A., M.D.

C.—*Geology.*—President, R. Etheridge, F.R.S.—Secretaries, T. W. Shore, F.C.S., F.G.S.; W. Topley, F.G.S. (Recorder); E. Westlake, F.G.S.; W. Whitaker, B.A., F.G.S.

D.—*Biology.*—President, Professor A. Gamgee, M.D., F.R.S. *Department of Anatomy and Physiology.*—Professor A. Gamgee, M.D., F.R.S. (President), will preside.—Secretaries, W. Heape; A. Sedgwick, B.A. (Recorder). *Department of Zoology and Botany.*—Professor M. A. Lawson, M.A., F.L.S. (Vice-President), will preside.—Secretaries, W. A. Forbes, B.A., F.Z.S. (Recorder); J. B. Nias, B.A. *Department of Anthropology.*—Professor W. Boyd Dawkins, M.A., F.R.S. (Vice-President), will preside.—Secretaries, G. W. Bloxam, M.A., F.L.S. (Recorder); T. W. Shore, jun.

E.—*Geography.*—President, Sir R. Temple, Bart., G.C.S.I.—Secretaries, E. G. Ravenstein, F.R.G.S.; E. C. Rye, F.Z.S. (Recorder).

F.—*Economic Science and Statistics.*—President, Right Hon. G. Sclater-Booth, M.P., F.R.S.—Secretaries, G. S. Baden-Powell, M.A.; Professor H. S. Foxwell, M.A.; A. Milnes, M.A.; Constantine Molloy (Recorder).

G.—*Mechanical Science.*—President, John Fowler, F.G.S.—Secretaries, A. T. Atchison, M.A.; F. Churton; H. T. Wood, B.A. (Recorder).

The organising Committees may hold such preliminary meetings as the President of the Committee thinks expedient, but, under any circumstances, will meet on the first Wednesday of the Annual Meeting at 11 a.m., to settle the terms of their Reports, after which their functions cease.

The different Sections will assemble in the rooms appointed for them, for the reading and discussion of reports and other communications, on Thursday, August 24, Friday, August 25, Saturday, August 26, Monday, August 28, and Tuesday, August 29, at 11 a.m. precisely.

Excursions to places of interest in the neighbourhood of Southampton will be made on the afternoon of Saturday, August 26, and on Thursday, August 31.

COAL PRODUCTION OF THE UNITED KINGDOM.

Since 1859, the tonnage of coal raised in the United Kingdom has been more than doubled, and the following particulars respecting this growth and its causes are extracted from an article in *The Economist.* Last year, according to the returns of the various Inspectors of Mines, the coal raised was no less than 154,184,000 tons, or 7,216,000 tons more than in 1880; 20,176,000 tons more than in 1879; and no less than 82,204,000 tons more than in 1859. For some four years subsequently to 1875 there was practically no growth in the production of coal; but now, as was the case in 1871-2, and before that, in 1864-6, there has occurred one of those remarkable leaps in the volume of the output which, for the time being, raises the question of the duration of our coal supplies.

Although the population has grown rapidly, the production of coal, as measured by the output per head, has grown yet more rapidly. The following figures show this to have been the case:—

	Population.	Coal Raised. Tons.	Coal Production per Head. Tons.
1881	35,246,562	154,184,300	4·37
1880	35,000,000	146,969,409	4·20
1875	33,000,000	131,867,105	4·00
1870	31,500,000	110,431,192	3·50
1865	30,000,000	98,150,587	3·27
1860	29,000,000	80,042,698	2·76
1855	28,000,000	64,453,079	2·30
1845	27,300,000	35,000,000	1·28
1800	16,000,000	10,100,000	·63

These figures, back to 1855, are from official returns, those for 1800 are from an estimate given in the report of the Coal Commission, and those for 1845 are Mr. McCulloch's. The great advance occurred upon the introduction of steam. Up to the 30th June, 1845, there were only 2,441 miles of railway in operation in the United Kingdom, and the bulk of that mileage was new and undeveloped, while ocean steamships were almost unheard of, and steam, even for manufacturing purposes, was used to a far smaller extent than it was ten years later. But between 1845 and 1855, when there were 8,835 miles of railway in operation, the production of coal increased upwards of one ton per head. Between 1855 and 1865, there was, however, a further increase in the output of nearly one ton per head, and taking a further ten years, to 1875, the growth was another ¾ of a ton. In the six years since 1875, the output has increased to the extent of another ⅜ of a ton, and last year the total quantity brought to the surface amounted to as much as 4⅜ tons per head of the gross population of the United Kingdom and adjacent islands.

To the uses of gas must be attributed a portion of the increased consumption of coal. There are no trustworthy aggregate figures at command upon this head; but taking the amount of gas manufactured at 80 thousand million feet, and that one ton of coal carbonised yielded 10,000 feet, we have a present consumption under this head alone of 8,000,000 tons per annum.

In the early part of this century, the export duties on coal checked the shipping trade greatly, and up to 1837 the exports of coal and coke never reached 1,000,000 tons a year. But in 1845, the shipments were 2,531,282 tons; in 1850, when the last of the export duties was removed, they were 3,351,880 tons; in 1860, 7,412,575 tons; in 1865, 9,283,214 tons; in 1870, 11,702,649 tons; in 1875, 14,544,916 tons; in 1880, 18,702,551 tons; and in 1881, 19,591,598 tons; so that the exports have increased six-fold since 1850. This, however, does not represent all the British coal consumed out of the country. In 1881, as many as 5,227,588 tons were shipped for the use of steamers engaged in foreign trade, and this is an item which had no existence prior to 1845.

An equally large consumption of coal in the United Kingdom must be assigned to the iron trade. The conversion of iron ore into pig metal, and its further manufacture into bars, plates, castings, machinery, and a host of miscellaneous requisites, probably do not absorb much less than one-sixth of our entire coal production.

It is estimated in Mr. R. Meade's "Coal and Iron Industries of the United Kingdom," that the known coal areas of the United Kingdom as yet unexhausted, and the supposed coal areas contain amounts as follows:—

	Tons Unraised. (40 per cent. for waste deducted.)
Known coal areas	89,015,613,000
Supposed coal areas	56,273,000,000
Together	145,288,613,000

All these 145,288 millions of tons are estimated to be at depths of less than 4,000 feet. At the present rate of consumption (154 millions of tons) this supply would last 943 years. But in the past 21 years, the consumption has increased at the average rate of 3,335,000 tons per annum. At the same annual arithmetical rate of progression it would take 250 years to absorb this mass of fuel. However fast the consumption may have increased, the estimates of the stock appears to grow still faster, for the evidence before the Lords' Committee in 1829 was to the effect that there were over 6,000 million tons of merchantable coal in the North of England, and that the South Wales and Midland coal basins probably each contained a larger supply, thus pointing somewhat indefinitely to supplies exceeding 18,000 million tons.

Obituary.

Sir Henry Cole, K.C.B.—The death of Sir Henry Cole, which took place on the morning of Wednesday, the 19th inst., though sudden, cannot be said to have been unexpected, since for some time back he had been suffering from the disease to which his death was due. Aware of the condition of his health, he had been gradually withdrawing from much of the work he has lately been carrying on in connection with this Society and elsewhere, though his indefatigable energy kept him still engaged on many of his favourite projects to the last. The daily papers of yesterday gave full accounts of the public services which Sir Henry Cole rendered to his country during a long life devoted to it. In these pages it may be desirable to sum up, briefly and incompletely it must be, but as well as can be hastily gathered from the Society's records, the work he has done in connection with the Society with which, since his first entrance into public life, he has been so intimately associated, and the direction of whose work he, more than any other of its members past or present, may be said to have influenced. The Society of Arts owes much of its present prosperity to the guidance and suggestion of Sir Henry Cole; and on the other hand, it has repaid the debt by lending its influence to the promotion of many of the proposals originated by him. In 1846, Mr. Cole, then in the Record Office, became a member of the Society of Arts. In the same year a medal was awarded to him, under the pseudonym of "Felix Summerly," for a tea service, which was made by Messrs. Minton, in competition for prizes offered by the Society. At the same time other medals were awarded to Messrs. Minton for articles in pottery of every day use, the designs of which, if not originated by Mr. Cole, were, at all events, influenced by his advice. In the following year, the year in which the Society was incorporated by Royal Charter, Mr. Cole was elected a member of the Council, very soon after he had read a paper here on the formation of a National Gallery of British Art by voluntary contributions. The Council were then actively engaged upon the preliminary work which resulted in the Great Exhibition of 1851, and it need not be said that its most active member was Mr. Cole. The holding of Annual Exhibitions of Works of British Industry, on which the Society was then engaged, was also under discussion, and the decision of the Council to discontinue these Exhibitions led, in the early part of 1850, to the resignation of Mr. Cole and certain other members. It was not, however, for long that he was off the Council, for a month after his resignation, in April, 1850, when a new Council was elected, Mr. Cole and his party were returned as part of it, by the general body of members, while his opponents were excluded. The new Council elected him as their chairman, an office which he filled for one year, and which he again held, after a short interval, in 1852. At his proposal, a rule was laid down by the Council, that the chairman should deliver to the members an annual address, and the first of these addresses was read by Mr. Cole, in January, 1851. Since his first election upon it, he has served almost continuously on the Council, till the present date. The holding of the 1851 Exhibition, the share the Society had in it, and the part taken by Mr. Cole, under Prince Albert, in carrying it out, are now matters of history. Unhappily Sir Henry was not spared to finish the biography upon which he was engaged, and in which it is probable much of the inner history of the Exhibition would have been found. It is, however, understood that a portion, at all events, of the work is complete, and that Miss Cole, his daughter, who was associated with her father in the work, has a considerable amount of materials for the remainder. In 1850, at the instance of Mr. Cole, a Committee was appointed to consider the Patent-laws and their reform. They published three reports, and put forward many suggestions which were incorporated in the Patent-law of 1852. From this time on, there were few of the multifarious objects of the Society of Arts with which Mr. Cole was not more or less closely associated. In November, 1852, the first number of the *Journal* was issued. The suggestion of a weekly *Journal* appears to have been due to Dr. Booth, but the carrying out of the project owed much to the energy of Mr. Cole. The Society took its part in the work connected with the Paris Exhibition in 1855, sending a deputation to visit the Exhibition, and two years later, in the foundation of the South Kensington Museum. It contributed £500 towards the purchase of the Soulages Collection, the acquisition upon which Mr. Cole had set his heart, and which was only effected after great trouble and energy on his part. The Educational and Food Collections of the Museum were also founded by this Society. The death of the Prince Consort, in 1861, led to the foundation of the Albert Medal in 1862, and in 1871 the medal was awarded to Mr. Cole, "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum." The subject of Musical Education, with which Mr. Cole was closely associated, was taken up by the Society in 1865, and in the following year a Committee, of which he was chairman, reported on the condition of musical education at home and abroad. The work on this subject was continued until it led to the establishment of the National Training School for Music in 1873. The organisation by which the scholarships for the school were obtained was entirely due to Mr. Cole, as indeed was the whole system on which the school was founded. In 1869, a paper was read by Mr. Cole on "A National Army in connection with the Industry and Education of the People." Mr. Mundella was in the chair, and the paper led to a discussion of three days. With the Annual International Exhibitions held at South Kensington, in 1871, and some succeeding years, the Society was closely associated; and reports upon them were published in the Society's *Journal*, and separately. These Exhibitions, it is well known, were originated by Mr. Cole, and carried on under his superintendence. From one of them grew the National Training School of Cookery. Mr. Cole had much to do with the foundation of this school, and kept up his interest in it to the last. At his instance the Society contributed several scholarships, which were competed for, and held at the school. In 1876, Sir Henry Cole (he had been made a K.C.B. the previous year) first seems to have turned his attention to the subject of sanitation, a subject which may be said to have engaged a considerable portion of his energies during the remaining three years of his life. He induced the Council of the Society to send a deputation to the Local Government Board on the subject of London drainage, and in the same year the first of the very successful and useful Sanitary Conferences of the Society was held. This movement was in its origin entirely due to the instance of Sir Henry Cole. So also was the idea of holding Congresses on Domestic Economy. Happening to be resident in Birmingham in 1877, Sir Henry occupied himself in promoting the Congress on this subject, which was held in that town. A similar Congress was held, in the following year, 1878, in Manchester, and the movement was continued by holding a Conference last year in the Society of Arts' Rooms. In the year 1877, also, a discussion on National Water Supply was held, in addition to a second Congress on Health. A proposal, in 1879, for a Universal Catalogue of Printed Books, put forward through the Society by Sir H. Cole, was less successful than some of his other suggestions. It would be impossible to chronicle here all the subjects at which Sir Henry Cole worked in connection with the Society of Arts. It may be fairly said that, during his long and intimate association with the Society, there was hardly any part of its action in which he did not take part, and generally a leading part. In addition to those already referred to, may, however, be mentioned the establishment of the Owen Jones Prizes, in commemoration of the well-known decorative artist, and the Mulready Prizes, in commemoration of the painter of that name. Those who knew Sir Henry Cole will be best able to perceive how incomplete is the above brief record of the services he has effected for the Society of Arts, and through its organisation. To give a full account of his connection with the Society, would be to prepare an abstract of the minutes of its Council and its Committees. He joined the Society when it was in very far from a flourishing condition. Its numbers were small, its resources slight, and its influence not very great. The good work it had done at the end of last century and the beginning of this was forgotten. It required reform and adaptation to the new times. This reform, this adaptation, was effected by Sir Henry Cole. He saw the Society, for which he had a sincere affection, and which he always seemed to regard as the most important organisation of its kind, growing in the number of its adherents, in wealth, and in influence, and he has now left it at a time when it is perhaps more prosperous than at any other period of its long and varied career. In his energetic pursuit of what he deemed useful public objects, it cannot be denied that he made many enemies. He had to fight violent opposition—opposition which only the strong mind, the most resolute will, could overcome. He possessed, to a large degree, that greatest of all powers—the power of subduing other wills to his own; and this, in the opinion of many who knew him best, was the great secret of his success. As time goes on, and when the small bitternesses of opposition are forgotten, it will come to be acknowledged that there are, after all, not many men who have made their mark more deeply on their time than he who has just passed away from among us.

MEETINGS OF THE SOCIETY.

Monday Evening, April 24, at Eight o'clock:—

Adjourned Discussion on "The Channel Tunnel." Lord ALFRED S. CHURCHILL will preside.

Wednesday Evenings, at Eight o'clock:—

April 26.—"Telephonic Communication." By Lieut.-Col. C. E. Webber, R.E.

Foreign and Colonial Section.

Tuesday Evenings, at Eight o'clock:—

April 25.—"The Character and Social Industries of the Inhabitants of China and Japan." By Lieut. the Hon. Henry N. Shore, author of "The Flight of the Lapwing." Sir Rutherford Alcock, K.C.B., will preside.

Applied Chemistry and Physics Section.

Thursday Evenings, at Eight o'clock:—

April 27.—"The Manufacture of Steel from Phosphoric Pig-iron." By S. G. Thomas and Percy C. Gilchrist.

Indian Section.

Friday Evenings, at Eight o'clock:—

April 21.—"The Mineral Resources of India, and their Development." By Prof. V. Ball, M.A., F.G.S., late of the Geological Survey of India. Sir Joseph Fayrer, M.D., K.C.S.I., will preside.

Additional Lecture.

Friday, 28th April, 4 p.m., "National Necessities as the Bases of National Education." By Dr. Richardson, F.R.S. E. Chadwick, C.B., in the chair.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Extra Ordinary Meeting. Adjourned Discussion on "The Channel Tunnel."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Valentin de Gorloff, "A Journey in the Atlas and the Northern part of the Algerian Sahara."

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. J. A. Higham, "The Adjustment of Mortality Tables."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 3 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Antiquaries, Burlington-house, W., 2 p.m.

Tuesday, April 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Lieut. the Hon. Henry N. Shore, "The Character and Social Industries of the Inhabitants of China and Japan."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. B. Tylor, "The History of Customs and Beliefs." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 52, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. Dugald Clerk's paper, "The Theory of the Gas Engine." 2. Mr. L. F. Vernon-Harcourt, "Harbours and Estuaries on Sandy Coasts."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. General Pitt Rivers, "Exhibition of Pottery from Silesia." 2. Mr. E. H. Man, "The Aboriginal Inhabitants of the Andaman Islands," Part II.

Wednesday, April 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Lieut.-Col. C. E. Webber, "Telephonic Communication."

Geological, Burlington-house, W., 8 p.m. 1. Prof. John W. Judd, "The Relations of the Eocene and Oligocene Strata in the Hampshire Basin." 2. Mr. Arthur W. Waters, "Fossil Chilostomatous Bryozoa from Mount Gambier, South Australia." 3. Mr. G. W. Shrubsole, "*Thamniscus:* Permian, Carboniferous, and Silurian." Mr. G. W. Shrubsole, "The Occurrence of a New Species of *Phyllopora*."

Public Analysts, Burlington-house, W., 8 p.m. 1. Mr. J. Muter, "A Fat recently extensively sold for the Adulteration of Lard." 2. Mr. J. Carter Bell, "The Action of Sulphuretted Hydrogen upon Compounds containing Oxide of Iron." 3. Mr. A. Smetham, "Some Analyses of Pure Coffee." 4, Mr. W. Hodgson Ellis, "The Water Supply of Toronto, Canada." 5. Mr. J. W. Gatehouse. "An Expeditious Mode of Weighing Liquids," and "The Composition of the Black Deposit which forms on the Electrolysis of Saturated Solution of Silver Nitrate."

London Instituion, Finsbury-circus, E.C., 12 noon.

Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m. Annual Meeting.

Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Second Exhibition of Spring Flowers.

Thursday, April 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Messrs. S. G. Thomas and Percy C. Gilchrist, "The Manufacture of Steel from Phosphoric Pig-iron."

Royal, Burlington-house, W., 4½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. Forbes Robinson, "The Cradle of Art."

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Augustus Stroh, "Attraction and Repulsion due to Sonorous Vibrations, and a Comparison of the Phenomena with those of Magnetism."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Metals." (Lecture II.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Liberal Social Union (Society of British Artists, Suffolk-street, Pall-mall), 7¾ p.m. Mr. Edward J. Watherston, "Our Iron Highways."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. Bird, "The Berlin Metropolitan Railway."

Friday, April 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Special Meeting.) Dr. Richardson, "National Necessities as the bases of National Education."

Royal United Service Institute, Whitehall-yard, 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Abel "Some Dangerous Properties of Dust."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning Society, University College, W.C., 8 p.m. Mr. John B. Bury, "On Browning's Relation, as a Poet to his Predecessors, as a Philosopher to Hegel.

Sat., April 29...Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Pollock, "History of the Science of Politics." (Lecture II.)

Journal of the Society of Arts.

No. 1,536. Vol. XXX.

FRIDAY, APRIL 28, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

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COMMERCIAL EXAMINATIONS.

In consequence of applications received from certain of the Institutions in Union, the Council have determined to revive the Examinations in Commercial Knowledge, discontinued in 1880.

The Council trust that the response made to this intimation will show that they were justified in acceding to the application.

It is obvious that the continuance of the Examinations must depend on their practical success, as evidenced by the number of candidates offering themselves for examination.

The Examinations in Commercial Knowledge will be held on Tuesday, the 20th, and Wednesday, the 21st June.

The Examinations in Political Economy, Domestic Economy, and Music will be held on Thursday, the 25th May, as already announced, and under the conditions stated in the Programme issued last November. No alteration whatever will be made in the arrangements of these Examinations.

The Commercial subjects for the present year will be—

1. Arithmetic.
2. English (including composition and correspondence, and précis writing).
3. Book-keeping.
4. Commercial Geography and History.
5. Shorthand.
6. French.
7. German.
8. Italian.
9. Spanish.

No Examination will be held in any subject for which less than 25 candidates offer themselves.

Certificates in two classes will be granted in each subject.

A fee of 2s. 6d. will be required from each candidate in each subject.

Committees having candidates for examination must apply, on or before the 1st of June, to the Secretary of the Society of Arts, for a form whereon to make their application for examination papers.

A programme of these Examinations can be had on application to the Secretary.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Council have arranged to hold an Exhibition of Modern English Art Pottery at the House of the Society towards the end of May. The following firms have, on the invitation of the Council, kindly consented to exhibit specimens of their work:—Messrs. Henry Doulton and Co., Linthorpe Art Pottery Co., Messrs. Maw and Co., Messrs. Mintons, Messrs. Wedgwood, and the Worcester Royal Porcelain Works.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

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INDIAN SECTION.

Friday, April 21st, 1881; Sir JOSEPH FAYRER, M.D., K.C.S.I., F.R.S., in the chair.

The paper read was—

THE MINERAL RESOURCES OF INDIA, AND THEIR DEVELOPMENT.

By Prof. V. Ball, M.A., F.G.S.,
Late of the Geological Survey of India.

I am not unmindful of the difficulty of the task which I have undertaken, namely, to endeavour to convey to you, within the limits of a short paper, a just conception of a very large subject which has manifold aspects. The more attention and the more time I have devoted to it, the more impressed have I been with the inapplicability to it of ordinary generalisations. Indeed, it may be said that any compressed statement of the facts must of necessity be untrue. It would be convenient, no doubt, to be able to characterise in a few words the values of the mineral productions of India, respectively; but what would or might be true of one part of the country would not be so of others. General statements have often been published, the effect of which has been, that a supposed rule has been applied unjustly to particular cases.

Few have attempted, hitherto, to bring together the information widely scattered in many publications, in regard to any single mineral production which is found in India; and thus the opinions sometimes expressed as to the value of the diamonds, the coal, the gold, the copper, or any of the other numerous products, are likely to have been tinged with the speaker's own particular local experience. You may often meet with one class of writers or speakers who refer to India as abounding, or being exceptionally rich, in valuable minerals; another class will tell you that the minerals of India are worthless. There is one class of newspaper writers who refer to the least known and almost unexplored parts of the country as being the richest in mineral wealth, but such confident statements have recently been surpassed by one where the author has ventured to state, that "the highest peaks of the Himalayas, under perpetual snow, without doubt contain enormous stores of mineral wealth, which only require the application of scientific knowledge for their development." We may, I think, justly be at a loss which to admire most, the confidence in his own assertion displayed by the writer, or his belief in the capabilities of science.

Nine years ago, my former colleague, Mr. W. T. Blanford, F.R.S., read a paper* on this subject, before your Society, and my acceptance of the invitation of the Council to re-introduce it to your notice has been given in consideration of the fact that in the period which has elapsed, much additional information has been obtained, and that of late years attention has been specially directed to the mineral resources of India.

Were I to devote the time available this evening to giving you an account of any one of the principal mineral products, I should not be able to do full justice to the subject; and this I say, having, on more than one occasion, attempted to do so without complete satisfaction to myself, before other audiences. Even the large volume I have written on the "Economic Geology of India" will be found to be only a brief *résumé* as regards some of the subjects treated of; and the reading of it, in order to a right understanding, should be supplemented by free reference to the fuller reports on which it is based. Its recent publication, however, absolves me, I venture to think, from going into details in this paper.

Upwards of 2,000 years ago the mineral productions of India were regarded as being of considerable value and importance, for Megasthenes has written, "India has, underground, numerous veins of all sorts of metals, for it contains much gold and silver, and copper and iron, in no small quantity, and even tin and other metals, which are employed in making articles of use and ornament, as well as the implements and accoutrements of war." Ptolemy and Pliny, and a host of subsequent writers, have left on record facts of great importance and interest; and in the correlation of these facts with those acquired in modern times, I have met with a number of remarkable results and identifications, some of which I have not as yet had an opportunity of publishing.

It would hardly suit the present occasion to follow the classification of subjects adopted in the "Economic Geology." What has to be said may most suitably be arranged under the following headings:—(1.) Precious and ornamental stones; (2.) Fuel; (3.) Metals; (4.) Salt; (5.) Building Stones; (6.) Pottery Clays; (7.) Miscellaneous. It is to be understood, however, that some productions I have not included in any of the above classes, but these are of minor importance, and may be omitted.

Precious and Ornamental Stones

India has, it is needless perhaps to remark, enjoyed a wide reputation since the earliest times as being a land wherein all or nearly all kinds of precious stones were to be found. If the term India be applied in the largest sense, as including some of the adjoining countries, especially Ceylon, Badakshan, and Burma, the statement is true; but if India be narrowed down to the limits of the peninsula, then some doubt must be expressed as to the occurrence of particular species of precious stones. It is certain that in very early times there were marts in India to which European jewellers repaired, in order to purchase many varieties of precious stones, but where some of these stones were obtained is not so clear, and the vague references of travellers are often not of much practical aid; indeed, it often happens, even at present, that it is extremely difficult to trace back to their original sources precious stones which have passed through many hands. All that can be said on the present occasion may be included under the following heads:—Diamond, amber, corundum, ruby, sapphire, spinel, beryl, emerald, garnet, lapis lazuli, turquoise, diamond.

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* *Journal of the Society of Arts*, vol. xxi, p. 386.

In the "Economic Geology" fifty pages have been devoted to a correlation of the hitherto widely-scattered facts regarding the occurrence of the diamond in India. I have succeeded in identifying the famous diamond mines visited and described by Tavernier in 1665, and by other still earlier travellers. Their identity was much disputed 100 years ago, and since then they have been simply alluded to as being forgotten and past hope of identification. I have also, I believe, fully established the oft-disputed identity of the Koh-i-nur with the Great Mogul diamond, which was described by Tavernier, who states that it had been found 100 years before his time, at one of the above-mentioned mines. Quite recently I have found a reference to apparently this identical diamond by Garcias ab Horto, who wrote just 100 years before Tavernier, or in 1565. These are but examples of the results which have followed from the reading of ancient historical notices, under the light thrown upon them by modern geography and geology. Even the old myth of the inaccessible valley containing diamonds, and the method of obtaining stones from it, described by Marco Polo, in the "Arabian Nights," and elsewhere, has been shown to rest upon a basis of fact.

The diamond-bearing tracts are situated in three widely separated regions, namely, in Madras; in the Central Provinces, with Chutia Nagpur; and in Bundelkhand. The geology of these is all more or less perfectly known, and it is possible to indicate roughly the limits of the actual diamond-bearing strata. That these have been exhausted is most improbable; and in spite of the large quantities of diamonds which have been taken out of the detrital deposits, it seems just to conclude that properly conducted operations would yield as many more, and by means of modern appliances, at a great saving of the amount of time and labour which was formerly expended. Under existing conditions in India, it may be doubtful whether it would pay to re-open these mines; but I am, on the whole, inclined to believe that the facts known regarding certain localities would justify systematic trials being made of the present productiveness of the mines and washings.

Amber.—This substance is not found within the British Indian territory, at least not in sufficient quantity to be of value; but in some tertiary coal-measures which are situated in the valley of the Hukung, in Upper Burma, there are mines which have been worked for a very long period. The amber which is obtained is in part carried to China by merchants, who visit the locality for that purpose.

Corundum, Ruby, Sapphire.—Although I have collected a number of ancient, and some comparatively recent, references to the existence of sources in India from whence the transparent forms of corundum—namely, ruby and sapphire—have been obtained, I am still inclined to believe that there have never been regular mines of either in India proper. The majority of the sapphires to be found for sale in India formerly, as at present, came, I believe, from Ceylon; and, in a similar manner, the rubies have been brought from the famous mines of Upper Burma. Corundum, however, is known to occur at so many localities in India, that the discovery of the mineralogically nearly identical ruby and sapphire, would not be surprising. Sapphires have at different times been reported to occur in the Himalayas. It is not inconceivable that it may hereafter be found profitable to export corundum from India to Europe, for manufacture into emery.

Spinel.—The spinel or *balas* ruby has been found, I believe, sparingly, in Southern India, but the principal localities where it has been mined for are situated in Afghanistan, Badakshan, and Upper Burma. Many of the famous and historical so-called rubies are now known to be only spinel.

Beryl, Emerald.—There appears to be no record of the green variety of the beryl, which is known as the emerald, ever having been found in India. This gem, so highly esteemed by the natives of India, especially by the Mahomedans, is imported from the European markets. The pale-coloured beryl or aquamarine, is, however, obtainable in several parts of the country.

Garnet or Carbuncle.—The cutting of precious garnets which are found in many parts of India, *en cabochon*, appears to have been practised since early times, and there is, at present, a small export trade in these so-called carbuncles.

Lapis Lazuli.—The most famous mines of this stone are situated in Badakshan. It is not known to occur, though it is much esteemed in India.

Turquoise.—This stone, which is much worn by some of the Himalayan tribes, is of very doubtful occurrence in India. The supply, it is believed, comes from certain famous mines in Persia.

Many ornamental stones may be mentioned, as, for example, cornelian, jasper, agate, jade or serpentine. The first three are found in great abundance in parts of Western and Southern India. Their cutting and polishing constitutes a famed industry of great antiquity, and which still exists in certain regions. Jade is found, but not worked, in several parts of the peninsula. In native Burma and in Karakash, to the north of the Himalayas, there are famous mines of it. Serpentine is found at many localities, both in peninsular and extra-peninsular India. A very superior class of steatite, much used for carvings, is found in Rajputana, but upon it heavy royalties and other dues are levied.

FUEL.

Under this heading three items may be included, namely, coal, peat, and petroleum; and, firstly, as regards

Coal.—The total consumption of coal in India by railways, manufactories, and steamers amounts, in round numbers, to 1,500,000 tons, of which about one-third, or 500,000 tons, are imported from Europe and Australia, and the remaining two-thirds, or 1,000,000 tons are raised in the country.* The different coal-fields which are at present worked contribute to this amount, roughly speaking, in the following proportions :—

Bengal ..	Raniganj......say	520,000 tons
	Karharbari .... „	390,000 „
Central Provinces. .	Warora ...... „	30,000 „
	Mopani ...... „	10,000 „
	Other localities „	50,000 „
		1,000,000 tons

Within the limits of the Indian Peninsula, the number of distinct and named coal-fields I estimate at 50; but it is to be remembered that the term "field," as applied to these, is not of equal force in all cases. In some it applies to distinct basins, in others to mere outcrops of coal measures on the margins of basins of sedimentary rocks. With a similar caution, the coal-fields of extra peninsular India may be put down at 36, so that we have a total of 86 fields, of which two only produce 300,000 tons and upwards per annum, and only two or three others are regularly worked. In reference to the above figures of the amount of imported coal, it should be stated that it does not include the by no means inconsiderable amount which, though brought to Indian ports by Suez Canal steamers, is not landed, being used for the return journey.

It may be predicted with certainty that the consumption of coal, from whatever source it may be derived, will increase steadily in the future. It is quite possible that, by the year 1890, the requirements of the railways, factories, and steamers, will considerably exceed two million tons.

In view of the high cost of imported coal, say from 17 to 20 rupees per ton, at the ports, the development of indigenous sources of supply assumes an ever-increasing importance. That considerable portions of the Presidencies of Madras and Bombay will continue to draw their supplies from abroad seems to be a necessary condition of the distribution of the coal-bearing areas, since Bengal coal from Calcutta, owing to its inferior heating powers, does not show much prospect of being able to compete successfully with foreign coal at Bombay or Madras, while the cost of inland carriage precludes these ports from drawing their supplies from the fields most adjacent to them.

In Bengal and the Central Provinces, on the other hand, a considerable development of the working of the coal-fields is possible. One point, however, cannot be too distinctly insisted on, namely, that it will not pay to make railways to the distant inland basins of Western Bengal and Rewah, simply with a view of bringing more coal to the ports and centres of manufacturing industry. Coal from such fields could not possibly compete profitably with that of the more favourably situated fields which are already worked. The use of such inland fields, therefore, must for many years be confined to supplying the requirements, firstly, of railways which may pass in their vicinity; and secondly, of manufactories, which it may, perhaps, be hoped will be more generally distributed in the future.

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* Perhaps two-fifths, or 600,000, and three-fifths, or 900,000, would be nearer approximation to the true proportions respectively.

Geologically speaking, the coal of India belongs to several different periods, all of which are more recent than is that of the true carboniferous measures of Great Britain. Practically, the question of the age of a particular deposit is of considerable importance, as with it the mode of occurrence varies considerably.

All the coal of any value which is found in the peninsula, south of the Ganges, belongs to a formation which corresponds in age to the permian and triassic periods of Europe. In the extra-peninsular regions, the coal belongs to differents parts of the jurassic, cretaceous, and tertiary periods. Each of these varieties of coal has its own particular characteristics, which affect its applicability to economic purposes. Into these distinctions I cannot enter now, it must be sufficient to state that the average coal of the peninsula, though very inferior in quality to average European coal, can be applied to most useful purposes, including its employment in sea-going steamers, where a high rate of speed is not required. But there is a consensus of opinion on the part of masters and engineers as to its unsuitability for steamers which have to run at a high speed. Much of the extra-peninsular coal, owing to its friable character, and the presence occasionally of other defects is of no value, and there is no prospect of the tertiary coals of North-Western India replacing the wood fuel at present used in the railways of that part of the country; but some of the tertiary coal of Assam is of high quality.

Peat.—True peat is only found on the lofty plateau of the Nilgiris, and in some of the Himalayan regions, namely Kashmir and Nepal. Accumulations of vegetable matter in certain of the swampy, low-lying parts of the country, to which the title has sometimes been applied, have no just claim to it, and are practically useless as sources of fuel. The applicability of the Nilgiri peat as a substitute for coal in Southern and Western India was discussed in a paper read before this Society* some years ago, but the favourable conclusion which was drawn depended on data in reference to the cost of imported coal, which were not correct then, and are still less so now. It is not to be expected, therefore, that Nilgiri peat can ever have more than a limited local value. The peats of Nepal, and still more that of Kashmir, are practically beyond our ken at present.

Petroleum.—The sources of petroleum are situated wholly in extra-peninsular regions, namely, in the Punjab, in Assam, and in Burma. The total yield from all the springs in the Punjab is not considerable, and in many cases is not worth the cost of collection. Mr. Lyman's estimate of the possible yield of petroleum in the Punjab, which he arrived at after a close examination of all, or nearly all the springs, was that they might be calculated to yield 100 gallons a day for eight years, after which the supply would probably fail. Since Mr. Lyman wrote, gas-works have been established at Rawulpindi, in which the oil obtained at two of the principal localities is manufactured into gas at the rate of 320 cubic feet per gallon, the lighting power being equal to from 14 to 15 candles; and in the year 1880 the total quantity of oil collected, amounted to 2,850 gallons, at a cost of nearly eight annas a gallon, or considerably above the retail price of American rock-oil in England.

The petroleum of Assam has attracted notice for many years, but hitherto attempts to work it have not been successful as commercial speculations. The failure, however, seems to be due to causes other than those attributable to the defects in the quality or quantity of the substance itself. The opinions of geologists, and others competent to express judgment on the subject, are favourable to the prospect of a profitable industry being possible when the means of communication shall have been improved, and when other difficulties, which have operated prejudicially, have been removed.

Whether it be true, as has been stated, that the exploitation of the rock oils in Upper Burma has been going on for 2,000 years, it is certain that there has for a considerable period been an unfailing supply from that source. Of late years, increased facilities for transport, and an increased demand, have called for a proportionately increased out-turn.

The so-called Rangoon oil is said to differ from that of British Burma, Assam, and the Punjab; but further proof of this is required.

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* *Journal*, vol. xix, pp. 201 and 206.

The first shipment of it to England was made in 1853, but whether the trade is now so large as it has been, I am unable to say, as the latest Burma returns do not distinguish between mineral and vegetable oils.

In British Burma, especially in certain islands off the Arakan coast, the oil springs have attracted some notice, and are now being worked by British companies; but it is still the fact that owing to no local refineries having been as yet established in Burma, the imports of American oil are considerable, and tend to increase in amount as the use of it for burning is becoming more common among the natives. In some parts of India, too, American oil is now obtainable, even in small and remote villages. Such being the case, the advantages which would follow from a cheap local supply of oil for lighting purposes becoming available need not be enlarged upon.

METALS.

Omitting from consideration on the present occasion, the less important metals, of the presence of which more or less abundant indications exist in India, I shall limit my observations to a few brief remarks on the following—gold, silver, copper, lead, zinc, iron, and tin.

Gold.—Regarding gold, especially in reference to the position it at present occupies in the eyes of British capitalists, I regret that I am obliged to write very much as an outsider, as, although when last in India, I was most anxious to visit Kolar and the Wynaad, I was unable to do so. My opinion of these southern regions is founded upon what I have read and what I have heard; I am, therefore, not unnaturally reluctant to press it upon my present hearers. All who have any interest in the matter are aware that the testimony as to the extent of the auriferous character of the quartz reefs is of a most conflicting character. The value of this testimony is now about to be put, at great cost, to a test which must decide it one way or the other, and such large sums of money having been embarked in the enterprise, the time for giving opinions or making useful predictions has, in one sense, at least, passed away. Any attempt at generalisation from all the available facts would be of little avail, and specific information regarding particular properties is not at my disposal. In my "Economic Geology" I have given an account, based on all the information available to me when it was written, of the many and widely separated tracts in India where the presence of gold has indisputably been proved. In some of these tracts the mode of occurrence precludes the possibility of a plentiful supply, while, in others, the abundance can only be ascertained from operations which, from the nature of the case, must be costly.

That a vast quantity of gold has been raised from the soil of India has, I consider, been fully demonstrated by the amplest testimony; but when we attempt, by facts at our disposal, to estimate the time and labour which have been expended to produce that quantity, we may feel doubt as to the profitable character of the industry. I know of numerous regions in India, where the indigenous gold washers eke out a precarious existence by the practice of their profession. All experience, however, warns us against attaching too much value to the bare fact of the existence of gold in alluvial deposits. It may in some instances indicate the existence of a large supply *in situ*, close at hand; but the actual presence of that large supply requires absolute demonstration in every instance, and cannot be assumed with safety.

Silver.—The fact that India ever produced silver in large quantity has hitherto been doubted by those who have expressed any opinion on the subject; but from evidence which I have obtained as to the abundance of a possible source of silver, I am inclined to accept literally, certain ancient and long-forgotten references to its having been a silver-producing country. Argentiferous ores occur in many parts of the country, and some of them contain high per-centages of silver.

Copper.—Copper ores occur in several of the older Indian formations, being sometimes found in regular lodes, but perhaps more commonly disseminated irregularly in the rocks which include them. As is well known, the latter mode of occurrence is not inconsistent with the presence of ore in sufficient quantity to be exploited with profit. In Southern India, in Bengal, in Rajputana, in Afghanistan, and in the Himalayas, as well as in some other regions, copper ores were formerly mined to a large extent; this is amply testified to by the the magnitude of the ancient workings, many of which were deserted long before they had a historian. The operations at otners, of which we possess a record, gradually diminished under the influence of the fact that imported copper undersold the locally manufactured article at the very mines. At the present moment, copper mining and smelting is only carried on in a few remote valleys in the

Himalayas and other localities. In the Nellore district, in Southern India, in Singhbhum, in Bengal, and in Kumaon, in the North-West Himalayas, attempts made to work the copper by European companies have not proved successful; but we should not, therefore, condemn the prospect which other localities might afford; nor would it perhaps be altogether just to accept as conclusive the operations which were certainly not conducted in all these cases with the requisite amount of skill. The failure by the natives, though in many cases due to actual poverty of ore, may, in some, be safely attributed to ignorance and to want of suitable appliances. The amount of metal manufactured bore but a small proportion to the amount of misdirected time and labour which were expended.

Lead.—With the exception of iron, there is no metal of which the ores appear to have been worked to so large an extent as have those of lead. The most common ore being galena, which is frequently more or less argentiferous, sometimes highly so, it seems probable that, as already stated above, the ancient workers devoted their attention to the extraction of the silver rather than to that of the lead. It is certain, however, that in some of the localities, considerable quantities of lead were produced, as for instance, in Ajmir, where the mines were of great extent, and had, in 1830, the appearance of having been worked for centuries. The final closing of these mines took place in the year of the Mutiny, owing to a natural desire upon the part of the authorities to make lead for bullets as scarce and difficult to obtain as they possibly could. In peninsular India the ores of lead occur in the older geological formations, and the localities where more or less abundant traces are found are numerous and widespread. The remarks made above with reference to the exploitation of copper ores, might be applied, *mutatis mutandis*, with equal force to those of lead. The same causes have resulted in the abandonment of mining operations by the natives. In the Himalayas, not far from Simla, lead mining was carried on for some years by a British company, but the success met with fell far short of the anticipations of those who embarked in the enterprise, and the works are, it is believed, now closed.

Zinc.—Traces of zinc ores have been found in several parts of India; but at only one locality, namely, Jawar or Zawar, in the Udepur State in Rajputana, have they been worked. The mines there were formerly of considerable extent, and the annual revenue derived from them is stated by Tod to have amounted to 222,000 rupees. The principal ore is Smithsonite or zinc carbonate, which was reduced in ingeniously contrived retorts. There are reasons for supposing that the same ore occurs in one of the Karnul galena mines, where it was probably treated as refuse, its character not being known to the native miners.

Tin.—Although ores of tin do occur in parts of the Indian peninsula, there is at present no evidence that they are anywhere of sufficient abundance to have been worked by the natives to any large extent; but in the native State of Bustar, in the Central Provinces, the inhabitants, it is believed, smelt a tinstone which is found there; and in the district of Hazaribagh in Bengal, about the year 1867, an attempt was made by an European to work a deposit of tinstone; but his operations not promising to be remunerative, were abandoned. The localities where tin ores are obtainable in Burma are very numerous. The majority of them are included in the strip of land in Tenasserim which extends from Yé to Maleewoon for a distance of about 400 miles. The sources of the stream tin, which is found in the majority of the rivers traversing this area, are situated in the range of hills separating British Tenasserim from Siam, and which continue southwards into the Malayan regions, where, as is well known, sources of tin are abundant and prolific. In Northern Burma, and in the Shan States, other sources of tin ore are believed to exist. The working of the Tenasserim ore is carried on by scattered colonies of Chinese, Shans and Burmese, and appears to pay them well; but an attempt made a few years ago by a British company, at Maleewoon, to work according to European methods, terminated speedily with loss.

It is worthy of remark that in the "Periplus of the Erythrean Sea," which was written about 1800 years ago, tin is stated to have been exported from Egypt to the ports of Western India, though it was known then to occur in other parts of India (? Burma and the Malayan countries).

Iron.—During the 13 years from 1867-68 to 1879-80 inclusive, the total value of the iron imported into India by the general trade amounted to 156,210,253 rupees, or at par exchange, say, £15,621,025. In other words, the annual imports during this period averaged in value upwards of £1,200,000. As the average imports by Government for the years from 1873-74 to 1877-78 exceed 120,000 tons, the value may be set down, perhaps, at from £500,000 to £600,000; but this statement is to be understood as being subject to correction, since the full figures are not before me. Taking into consideration the large imports of the last few years, it is very probably an under estimate. It is for our present purpose sufficiently apparent that India consumes, and has to pay for, very large quantities of iron, and what we have to consider is, whether any considerable portion of the requirements might not be supplied from indigenous sources.

I cannot here attempt to give even a sketch of the wide distribution of all the different ores of iron which are found in India, nor is it possible, within the space and time at my disposal, to trace the histories of the various efforts which have been made by British companies to establish the profitable manufacture of iron at several widely separated and differently circumstanced localities. The process of iron manufacture, as practised by the natives, has much connected with it, of both historical and technical interest, which constitute it a not unprofitable subject for study by itself; and much might be suggested with reference to the improvement and development of that process.

The costly experiments which have been made by companies have served to prove several facts, of which the principal are—*first*, that materials suitable for the manufacture of excellent iron do exist; *second*, that, while in some of the localities chosen, the manufacture could not possibly have been conducted with success, in others the conditions were more favourable, and that in consequence of the information so obtained no hesitation need be felt in the selection of the best of localities hereafter, should the industry be again started; *third*, that the iron produced at one locality will only be applicable to certain special purposes, and that from the sameness of the materials employed, iron, but of a limited number of varieties, can be produced; *fourth*, that the margin of profit upon local manufacture will, under the most favourable circumstances, be a very narrow one—so narrow as to be subject to be swept away with the oscillations in prices in the English market. At the same time, it must be borne in mind that India is so large a customer of England, that a failure of demand from that quarter would certainly result in the lowering English prices to a considerable extent.

It is my belief that a factory on a small scale could not possibly pay in India. It could not afford to keep up such an establishment as would provide for the carrying on of operations in the event of casualties, and from this and other causes, its operations would be subject to interruptions, which would be fatal to success.

Whether a colossal scheme of iron factories working in connection with one another at different parts of the country might not be successful is another matter to which attention may well be directed. It seems to be not improbable that had the Government started the manufacture of iron on an extended scale,* when the trunk lines of India were being opened up, great benefit would have accrued to the State. That it would have been possible, politically speaking, for any Government to have done so continuously, may be doubted, owing to the opposing interests involved; but had there been a special department of the State—similar, say, in its organisation, to the Forest or Salt Departments—it is certain that the effect of establishing factories for iron manufacture would have been to keep vast sums of money in circulation in the country, and to have given employment to large numbers of people who now crowd the land.

In a suitably officered department there would be a margin of officials, to allow for leave and casualties; and, what is perhaps of more importance, the managers of individual factories would be upheld in their authority by a *prestige* which the managers of companies do not possess, and the want of which was a cause of incessant trouble at Bepur, Dechanri, and other places.

Whether a large scheme be ever undertaken by private enterprise or by the Government, the production of a variety of classes of iron should, if possible, be attained. Not only should the factories be able to turn out good qualities of rails and bar, but by producing an easily malleable iron, such as that made in the simple charcoal furnaces of the natives, and which commands a very high price, the use of iron in the interior might be largely extended, and an important industry created.

Of other metals found in India, besides those above mentioned, the most important are platinum, cobalt, manganese, and chromium. The occurrence of mercury is doubtful. Regarding what is known of these and a few other rarer metals, full particulars will be found in my volume.

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* A half-hearted attempt made at Barwai, in the Narbada Valley, never reached a successful issue.

SALT.

Salt has hitherto enjoyed the position of being, in reference to the Indian reveuue, by far the most important mineral production. Many other mineral productions with which the Indian Government have to do, such as gold in terms of silver, iron, and coal, are distinguished by the outgoings of revenue, but the salt-tax has yielded a nett annual income of easy incidence amounting to nearly £7,000,000. The tendency of the latest legislation has been, however, to reduce this amount, but as my proper subject on this occasion has reference to the sources of the salt supply, I do not propose to wander into any discussion of that part of the question. It is legitimate to refer here, however, to the masterly arrangements which have been made within the past decade, by which it has become possible to do away with the Customs line, and by which the manufacture of salt in native territory has been abolished, while the illicit extraction of salt is no longer practised.

The sources of the salt supply of India are as follow:—1. Importations, chiefly from the United Kingdom, but also from Arabia and elsewhere. 2. Sea-salt. 3. Lixiviation of saline earths. 4. Saline springs, wells, &c. 5. Salt lakes. 6. Rock salt.

1. The total of imported salt amounts to about 300,000 tons per annum.

2. The manufacture of salt from the ocean, in pans, either by solar or artificial evaporation, has been carried on since very early times in various districts and regions which are adjacent to the coast. Without entering here into details, it may be said that, at present, the industry, whether carried on by a Government monopoly or by private farmers, their sales only being taxed, is restricted to portions of Madras, Bombay, the province of Orissa, in Bengal, and parts of Burma. The artificially evaporated salt, though of distinctly purer character than that which is produced by the heat of the sun, is not used by the stricter Hindus, as they regard it as having been cooked, and therefore, impure.

3. *Lixiviation of Saline Earths.*—The soil of many parts of India is largely charged with a variety of salts, the concentration of which has resulted from a high degree of atmospheric evaporation, unaccompanied by subsoil drainage. The effect of irrigation on such lands, even with the pure water of the Ganges canal, has, in not a few cases, produced sterility in a manner which admits of a very simple, though not at first sight, obvious explanation. It is, in brief, that the general level of the highly saline subsoil waters have been raised to a level where they can act prejudicially by the deposition of the efflorescent salts, collectively called *reh.* The preparation of salt by lixiviation of such saline earths, though once largely practised, is now nearly extinct.

4. *Saline Spring and Wells.*—These are very abundant in parts of Assam, Burma, and the Punjab. As is the case in other parts of the world, they frequently occur in conjunction with petroleum springs. Wells have been used in many parts of India to extract the above natural subsoil saline waters, from which very large quantities of salt have been, and still are, manufactured.

5. *Lakes.*—As in America, there are also in India some notable examples of lakes which, having more or less extensive drainage basins but no outlets, deposit salt when, during the heat and drought of summer, the limit of saturation is passed. The principal of these lakes are situated in Rajputana, and among them the Sambhar Lake is the most important. The manufacture of salt, since it came into British hands, has been largely developed, and the total annual out-turn now exceeds 100,000 tons.

6. *Rock Salt.*—In the Punjab there are two distinct geological formations, which include deposits of rock salt of enormous extent. One of these, believed to be of Silurian age, is situated in the salt range on both sides of the Indus, while the other, of probably eocene age, lies wholly trans-Indus in the district of Kohat. The former is worked by means of mines, and the latter by open quarries. The produce of both is sold locally, and of the former the sales in 1871 amounted to £388, 14s. 4d., and have since, it is believed, increased, but the figures are not available. Into further details I cannot now enter, only stating that in some of the bazaars, in the cities of Northern India, the different varieties of salt from the above sources are to be found for sale side by side, so as to suit the tastes of purchasers of different nationalities who are accustomed to the use of the respective qualities, and who are often very fastidious in this matter.

Carbonate of Soda.—Carbonate of soda is obtainable in some abundance, by lixiviation of soils derived from the disintegration of the volcanic rocks which abound in the Deccan. A remarkable deposit of it is annually formed in the Lonar Lake, in Berar. Owing to the large artificial preparation of carbonate of soda in Europe, the value of the natural product has much decreased, and the export from India is now inconsiderable.

Borax.—Within the limits of British India there is no known source of borax. But it is obtained in the Puga Valley, in Kashmir, where it is deposited by hot springs. In Thibet there are numerous not very well known localities, where it is produced in abundance. From both these regions there are large imports into India, and a correspondingly considerable export trade of so-called *tincal* to Europe.

Saltpetre.—The fact is generally known that India for a long time enjoyed the monopoly of the trade in saltpetre, though few people perhaps have realised that the elements which combined to form this essential constituent of gunpowder were derived from the ammoniacal refuse, in combination with wood ash, of old Indian village sites. Such is, nevertheless, the case, and is a remarkable instance of how elementary substances are conserved to reappear in new combinations.

Natural deposits of potassium sulphate, and other sources of supply of the requisite materials, have resulted in the diminution of the Indian trade. The manufacture in Northern India, though formerly monopolised by the East India Company, is now in the hands of natives who are under the control of a system of excise. The exports from Calcutta in 1879-80 amounted to 463,110 cwt., valued at £431,814. Recent reductions in the duty have been made, but apparently too late to restore the trade to its former position.

BUILDING STONES.

It would be a grievous error to omit in this enumeration all mention of the building stones which have played such an important part in the architecture of India. Some of the varieties are notable both for their durability and tractability; others, while of equal and even greater durability, are much less tractable, and when employed in ornamental work, have only yielded to the patient pertinacity of the skilled artisans, who have left imperishable records of their handiwork in the ancient temples and palaces of certain regions in India. Still another class included those varieties, often very tractable, and more or less durable, which are characterised by their beauty and applicability to ornamental or decorative purposes.

In the palaces, mosques, tombs, and forts of the ancient cities in the north-western provinces of India; in the wondrous monoliths, some of huge dimensions, which were erected in the time of Asoka, or about 2000 years ago; and, finally, in the Hindu temples scattered all over the country, more especially in Southern India, we have evidence of a kind not accessible to the architects of newer countries, as to the durability and susceptibility to delicate treatment which these building stones possess.

On previous occasions, when writing of this subject, I have been compelled to condense and generalise the vast amount of information which exists upon it. On the present occasion I must assume it as demonstrated that inexhaustible stores of the most valuable kinds of building stones do exist, and must confine myself to a few suggestions as to how these stores may be most profitably availed of.

By the British in India the employment of stone for building has been local and exceptional, the city of Bombay affording the most notable of these. The comparative cheapness of bricks in the alluvial regions, where most of the great cities of Northern India are situated, has no doubt been the principal cause of their adoption. Hence it is that, in the majority of the cities, bricks and stucco predominate. But it might be worth consideration and calculation whether, in the long run, it would not be cheaper to employ stone more often than it has been hitherto. The destruction of stucco work by tropical rains is considerable, and it seldom looks well, except for a short period just after it has left the plasterers' hands. The amount paid annually by the Government for repairs of this kind of work must be very considerable, and it would, if capitalised, in all probability more than pay for the initial expense involved in the use of stone. Massive stone buildings would be cleaner and cooler, and therefore healthier, than those at present in use. Already some of the principal quarries are connected by railway with the cities of both Northern and Southern India.

It is a most singular fact that, although the marbles of India are unsurpassed for their beauty and variety, those which are used for flagging and for tombstones in India are nearly all imported from Italy, China, or the British Isles.

Some of the superior qualities of marble, there is reason for believing, would be applicable to statuary purposes; but in order that the marbles of Rajputana, which are the finest in India, should get into the market, it would be advisable for the several durbars to reduce the high royalties which they at present levy. Thus the cost of the marble in the famous Makrana quarry, in Jodhpur, is three rupees eight annas per cubic foot, out of which two rupees goes as royalty to the State. The marble of which the Taj, at Agra, was built, came from this quarry.

POTTERY CLAYS, &C.

The pottery clays most commonly used in India are of the coarsest kind, and the ware prepared from them is baked at a low heat. In certain parts of the country finer and more refractory clays are used for special varieties of pottery. And there can be little doubt that were the occasion to arise, clays of high quality would be forthcoming. There is at present one European pottery in Bengal, the work turned out by which demonstrates the excellent quality and variety of the materials which are obtainable in the vicinity of Raniganj. Good fire-clay is obtainable it is known by actual trial in several parts of the country, and would probably be found in other parts should occasion for its use arise.

MISCELLANEOUS.

Under this general heading I include a few of the many mineral substances not above mentioned, but which occur in India, and have a greater or less commercial value. These are, graphite, or plumbago, sulphur, alum, mica, and asbestos.

Graphite, or Plumbago.—Traces of this mineral occur in many parts of India, but owing either to impurity, or the scantiness of the deposit, the majority do not appear to have any real value. The most promising graphite is that which occurs in the Travancore State.

Sulphur.—The sources of sulphur in India are for the most part limited in extent, and are only sufficient to supply local demands. They are chiefly connected with the occurrence of hot springs. The most prolific sources are situated in regions too remote to admit of their product being brought into competition with imported sulphur.

Mica.—This mineral, which is popularly but incorrectly spoken of talc, is obtainable in quantity, and in plates of large size, in the Hazaribagh district in Western Bengal. There is at present a small export trade, principally to Germany, I believe. Mica is largely used, too, in India, for various ornamental purposes.

Asbestos.—So far as is known, the most promising sources of this mineral are situated either beyond the limits of British territory (*e.g.*, Afghanistan), or in localities difficult of access (*e.g.*, Garhwal). Small quantities are obtainable at more accessible localities, and in view of the growing importance and value of the substance, it would be well if those who may have the opportunity of doing so would direct their attention to the discovery of a plentiful supply.

Passing from the foregoing all too brief sketch of our present knowledge of the useful minerals of India, it now remains to consider how that knowledge may be best availed of. Hitherto, the insuperable drawback to the development of mineral resources in the remoter regions of India has been the want of cheap and efficient carriage, not only for the transport of the outturn from the mines, but also for the transport of men and materials to the mines. Throughout a steadily increasing area this want of carriage is being removed, by the extension of lines of railroad. Over and above this insuperable difficulty, there have been other causes, which have interfered with the success of mining operations; these causes, though by no means insuperable, have been none the less real.

The policy of the supreme Government with reference to the encouragement of private enterprise cannot be treated or spoken of as a constant quantity; it varies from time to time. In the last few years it has been distinctly favourable; but there is the strongest reason for believing that these more favourable views have not to any great extent filtered downwards into the departments, or to the individuals with whom investors or capitalists would be likely to come into contact. The bureaucratic mind in India is most distinctly antagonistic to private enterprise. Not only have those who seek for information about prospecting or mining leases to wait for months for replies, but when they do, if they ever receive them, they are, in the majority of instances, framed in such a fashion as to give no security to those who might be willing otherwise to risk their money.

Leaving out of consideratlon the special and local legislation referring to certain gold-fields, there is, as regards the greater part of India, no custom nor rule, no well-established precedent, not to say no mining laws. The rights to which the Government succeeded as the paramount power, having lapsed through the neglect which arose in the first instance, from the pettiness of mining as a source of revenue, there is at present great uncertainty as to whom these rights belong.

Suppose a capitalist to deal with an existing proprietor of the surface rights, he may find, after much expenditure has been incurred, that a previous lord of the soil interposes with a claim that, when disposing of the land, he did not alienate the mining rights from himself. Thus the capitalist may find himself involved in tedious and costly litigation at the very threshold of his operations. Such a case is by no means a hypothetical one, and it is in a great measure owing to this unsatisfactory state of things that people will not risk their money in enterprises which have drawbacks of this nature, in addition to the uncertainty inseparable from all matters connected with mining.

I shall give two instances of bureaucratic opposition, for the accuracy of which I can vouch. In the first, a gentleman in Europe, who had read an account of certain diamond mines in India, addressed a petition to the Government of India, asking to be allowed to embark his capital in the working of these mines. After many months' delay, a reply was sent to him, which drew a purely fanciful picture of the difficulties and dangers connected with a residence in the locality, and in order to complete the repellant features of the prospect, he was told that a preliminary searching lease would be granted to him for a limited period, under vague restrictions as to the rights of the Government in the diamonds which were found, but that after the completion of the term, he would not be entitled to an exclusive lease. In other words, it might have been told him that he would be allowed to expend his capital, and risk his health for the benefit of the public at large.

In the other instance, a gentleman in India desired to obtain a lease of the mineral rights in the estate of a semi-independent raja. With this in view, he despatched a native agent to arrange preliminaries with the raja. These had, I understand, been almost completed, when the Commissioner of the province hearing of the matter, simply put an end to the transaction by ordering the agent to leave the district. Nor was any word of explanation vouchsafed to the agent's employer.

In parts of the country, the independent European is regarded as an interloper, and some district officials are apt to think more of the trouble which may accrue to themselves, in consequence of the presence of such Europeans, than of the general benefit to the community at large from the establishment of industries calculated to give employment to large numbers of people. This charge is not made lightly, nor without a firm conviction of its truth, and the fact that it may not be palatable in certain quarters, would not justify my failing to give expression to it, as I conceive it to be a very real cause of hindrance to those in India who are anxious to develop the mineral resources of the country.

Among the changes in the existing state of things to which I desire to draw attention, as being likely to afford a means of furthering our actual knowledge of the value of the mineral deposits, I include a radical alteration in the conditions of service in the Geological Survey of India. At the present moment, the officers of that department are subject to the rules as regards length of service and amount of pension, which govern the heterogeneous collection of departments known as the uncovenanted service. These rules involve a term of service of 30 years before any pension can be obtained, unless under sick certificate, testifying to incapacity, or unless the age of 55 years has been attained. In order to do his work properly, an Indian geologist must be in full physical vigour. No amount of mental qualification will make up for inability to walk for many hours daily under a tropical sun, or for inability to withstand the attacks of sickness arising from exposure to exceptionally unhealthy climates. It is difficult to convey an idea to those who are not professional geologists of the downright drudgery involved in such work, if it be honestly performed. The average mortality among officers belonging to the department is exceptionally high, and there is at present a large per-centage of them in indifferent health, brought on by exposure. It may be perfectly true that, in the future as in the past, the Government will find no great difficulty in filling up vacancies. Whether urged by the desire of obtaining immediate employment, or simply by scientific zeal, more or less qualified geologists will be forthcoming; but men who have had practical experience at home, and who are not in their first youth, are not likely to—and do not, as a matter of fact—come forward to offer their services for such almost visionary ultimate rewards as are held forth by the Government at present. Far be it from me to suggest any suspicion of doubt as to the excellence of the work which has been accomplished in the past; but what I want to convey is, that a stronger leaven than at present exists, of men with practical experience based upon scientific teaching, is a distinct desideratum in the Geological Survey, with special reference to the future extension of mining enterprise in India.

The Government of India is not unsparing in its rewards, both honorary and substantial, for good service to the officials in certain departments, and it would not only be a fitting recognition of the past services rendered by those who at present belong to the Geological Survey, but it would also secure to them a new class of recruits in the future, if they were to modify the existing conditions of service, which are wholly unsuitable to a body of men who are called upon to perform such exceptionally arduous work as that which is involved in the geological exploration of India.

In the regulation districts of Bengal, where the permanent settlement is in operation, the silence in that settlement in reference to mineral rights has been interpreted in favour of the zemindars by the law officers of the Crown, and the zemindars are free to make their own arrangements; but in those cases where there has been transfer of the land, these rights may still be subject to litigation; and, as a matter of fact, such cases have already arisen.

On the other hand, in the non-regulation districts, no step has as yet been taken by the paramount authority to reassert its indubitable original rights in all minerals. Such a statement, coupled with the enactment of mining laws similar to those in force in Australia and in parts of the Continent are, I submit, distinctly called for by existing circumstances.

Nothing more cramping and obstructive to the operations of prospectors can be conceived of than having to deal with native proprietors, whose sole idea is to impose exorbitant and impracticable royalties. It cannot be expected that prospectors will expend their labour and capital in demonstrating to such proprietors the value of the minerals in their lands without some equivalent security as to the terms upon which the mining rights, if of proved value, will be leased or sold to them.

I might quote numerous instances where the zemindars levy what are, I believe, illegal royalties on the indigenous native workers in mineral products, and where such royalties have either crushed the industry altogether, or have reduced the miserable workers to depths of poverty, the profits of their industry and laborious struggles being all taken from them.

The benefits to the native community of an enlarged system of mining might be illustrated by many facts which have come under my own observation, in Bengal, of people crowding in such numbers to where work was offered them, that the managers of the mines have been absolutely compelled to drive them away.

The establishment of mining, and connected manufacturing industries, would afford suitable means of employment, too, for a rapidly increasing class, whose future should be a matter of grave concern to the Indian authorities. I allude to those of European and Eurasian parentage, the greater portion of whom are in poverty, in consequence of the scarcity of suitable employment. Many a time have I felt saddened, when seeing hundreds of the young lads who turn out on the Calcutta Maidan to play football, and so far show that they have not degenerated, when I reflected that but for a small fraction of them could India, in its existing condition, afford a profitable and prosperous career.

It is my belief that, until facilities are afforded to prospectors to open up the deposits, and until these facilities have been largely availed of, we shall not be in a position—because we have not, in fact, sufficient data—to form a confident opinion as to the value of the majority of the mineral resources of India.

In conclusion, I have to apologise for having occupied so much of your time, without having even touched remotely upon some of the aspects of this important subject. It is one which I feel convinced will attain greater and greater importance as the years go by, and which therefore now urgently calls for speedy and liberal legislation.

Statement of the Values of the Mineral Production Imported into India during the official year 1879-80.

	Quantity.	Rupees.
Precious stones (including pearls) ..	..	1,552,739
Coal, coke, and patent fuel	608,760 tons	177,40,715
Petroleum	7,888,247 gals.	4,819,079
Sulphur	13,319 cwt.	11,290
Arsenic	300 ,,	5,256
Mercury	531,393 lbs.	588,436
Gold (including coin)	..	20,503,929
Silver	..	96,050,019

	Quantity.		Rupees.
Copper	386,173	cwt. ..	16,201,547
Brass	10,279	,, ..	538,484
Lead	73,480	,, ..	1,062,958
Zinc	127,138	,, ..	1,443,599
Tin	20,840	,, ..	988,459
Iron*	2,111,156	,, ..	12,293,847
Lime and chalk	43,739	,, ..	19,294
Salt	353,238	tons ..	7,625,321
Saltpetre	3	cwt. ..	49
Borax	34	,, ..	922
Building stones, millstones, grindstones, &c.	17,423	,, ..	93,414
		Total	175,609,427

Or in sterling at par, £17,560,942 14s.

DISCUSSION.

General APPLEGARTH said:—We must all be very much obliged to Mr. Ball for the interesting paper he has given us; but I am sorry to see he has left poor Madras out in the cold, and told us there is no prospect of obtaining coal in that province. I should, therefore, like to give a short account of my discovery of coal there in 1851. In 1849, Sir Arthur Cotton, R.E., K.C.S.I., appointed me as Assistant Civil Engineer in sole charge of the Kistnah district, which contains about 3,000 square miles of country, adjoining the Nizam's dominions, and having been directed to build a lighthouse at Point Devy, I was fortunate to find a suitable limestone, and I built the lighthouse which is there now. While examining the strata of limestone, I commenced a horizontal shaft into a red shale hillock, and bored seventeen feet horizontally into this hill of shale, and a black substance like the Torbane-hill mineral was found; this substance ignited, and became a red-hot fire. We quarried several tons of it to make sure our prize was a genuine one. I also induced the native blacksmiths to utilise it, which they did. I immediately reported the discovery to the Madras Government, and forwarded specimens of the coal to Madras. This is the correct account of the original discovery of the Kistnah coal, which Professor Ball, at page 644 of his book, styles pseudo-coal sent from the Kistnah. In the autumn of 1851, I came home to England, and in 1852, I reported my discovery to the Court of Directors. However, not till 1868 did the Geological Survey move in the matter, when the superintendent of the Survey then inspected the locality, having previously ignored the possibility of coal occurring there, and reported unfavourably of the district. Mr. R. B. Foote, of the Geological Survey, in 1872, made and published seven sections of the Kistnah district rocks; but not one of the seven commences from, passes through, or terminates at Juggiapettah Town, where the Lower Coal rocks (Talcheers) are extensively and plainly developed; and in 1874 the newspapers of Madras published an account of Mr. Foote's opinion, that the Kistnah district rocks resembled the coal rocks at Singareney. Professor Ball next alludes, at page 70 of his "Economic Geology," to borings which, he says, were made at points indicated by Colonel Applegarth with his own hand, on his own map. But he is mistaken. The following are the facts:—Eleven borings were made, ten of these borings averaged only 27 feet deep, and one boring was 110 feet deep. At one spot I had pointed out three borings were made: one boring was 7 feet deep, one was 8, another was 23 feet deep. At another spot where I had recommended a horizontal shaft a vertical one was made. At the third spot at which I had recommended a boring, 110 feet deep, 57 feet of hard and soft black shale were cut through. This black substance has been called a variety of names, such as pseudo graphite, coal smut, burnt shale, &c. I believe this black stuff is coal that has been partially burnt, as it has the appearance of coke, and under a magnifying glass it presents every appearance of coke, or burnt coal, and, when ignited, burns like a coke fire. It may even be a natural bed of coke. There were seven other localities which I had particularly recommended to be looked at by the Survey Department, but none of these appear to have been reported on or examined. And as for these borings for coal, of 7, and 8, and 23 feet deep which they did make, such would not satisfy any ordinary coal viewer. The members of the Geological Survey state as their opinion, that the rocks of the Kistnah district are Cuddapah rocks:—"Formations long anterior to the coal rocks of India, and their lithological and metamorphosed characters, were wholly inconsistent with the idea of coal occurring with them;" and Professor Ball says, that there was, moreover, no more reason for coal occurring there than in any other part of the districts where the same rocks are found." Even this dictum is opposed to the fact which he notices when the Singareney coal and its rocks are brought under review, as here the coal and its rocks some times rest on Talcheers, and elsewhere on the old Cuddapah rocks, or on Gneiss (See "Manual of Geology for India," part 1, page 241). I may mention that the Singareney coalfield was discovered by Mr. King, F.G.S., but the territory belongs to H.H. the Nizam of Hyderabad. There are several seams in it, and one 34 feet thick of solid coal. This coalfield is situated on an important affluent of the Kistnah River, and is only 33 miles north of the British boundary of the Kistnah district. I may also mention that the Kamarum coalfield (situated a little to the north of the Singareney coalfield) is surrounded by Cuddapah rocks, and on the south-west the coal rests on these Cuddapah rocks. However, Professor Ball has stated the coal is fair, and that there are 1,132,560 tons of available coal. It is important to record coal-bearing rocks (see "Manual of Geology," part 1, page 240) extending for six miles at the hill of Kunnigherry, which is situated within 15 miles of the Kistnah district.

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* Exclusive of imports by Government, the return of which is not accessible to me.

I am able to advance one more most important proof of coal found associated with the Cuddapah rocks, alluding to the Godavery and Wurdha rivers (see "Manual of Geology," part 1, pages 228, 229, 230), where the coal is fair and plentiful. Professor Ball, in his "Economic Geology," page 93, estimates the available coal here at 1,714,000,000 tons. And as a caution to the too hasty condemning of the Kistnah district, I must mention that the late superintendent of the Geological Survey in India published a memorandum under Mineral Statistics, dated Calcutta, 1st June, 1861, that there was no true coal on any of those rivers. I believe this memorandum is now out of print, but it was originally published in vol. 3, page 215, Geological Survey Records. There is still one more subject of importance connected with the eastern part of the Kistnah district; I allude to the coal found at Beddanodole, which rests on metamorphic rocks. My authority for this statement is the "Manual of Geology for India," part I., page 239. The engineer who made these borings is of opinion that there is more coal to the south-west, that is nearer the Kistnah district (this part is still reported under progress, Vol. 16, part 3, page 11); but the Geological Survey have now reported, and drawn on their maps, several hundred square miles of country containing Indian coal rocks, and have marked coal strata within eight miles of the navigable canal to Madras. All these are promising indications of coal to be obtained from this eastern portion of the Kistnah district; but I would point out that in the map that accompanies Vol. 16, part 3, the colouring artist has been a little too lavish with his pink colour, and has painted as gneiss what is in reality hydraulic limestone and a diamond conglomerate (plum-pudding stone), both these rocks occurring close to the village of Kistnaveram, which is covered over or hidden by this pink colour. The published official documents of the Indian Geological Survey, up to 1881, notify that coal has been found in exactly similar rocks to those of the Kistnah district, where, thirty years ago, that is, in 1851, I discovered coal as I have just related. This will dispose of Professor Ball's suggestion at page 71 that the Beddanadole coal of 1874 was the first genuine coal discovered in the Madras Presidency, and I am anxious to appeal to the Chairman, and to this meeting, as to whether I have not had good grounds for so constantly urging the Madras Government to have this long disputed coal locality more fully and more thoroughly explored.

Mr. Hyde Clarke said he must concur with General Applegarth in the tribute he had paid to Professor Ball for his interesting paper. The latter portion of it was one of great importance, and would probably strike those outside of India, even more than Indians themselves. There was hardly a country in the world which had minerals at all, which was in the condition in which India was in regard to mining. In every country where mining was carried on, there was a general mining law, which was a free mining law, and even in England there were vestiges of it in the Duchy of Cornwall. The right of prospecting was generally a free right, and when a man had prospected, there was in most countries a provision that on registering in a local office, at an expense generally of about £1, he obtained the right to work a certain district, and he could at once apply to a capitalist to work with him almost as safely as if it were his own freehold property. The introduction of a mining law in India on a similar basis to that of Spain, or rather of New Spain, which generally governed South American countries, was a matter of the very greatest importance for the development of those mineral resources of India, of which Mr. Ball had given such good evidence. Many points in the paper invited comment, and some persons might think that Mr. Ball had been somewhat remiss in the manner in which he had treated the subject of gold mining; but he had expressly restrained himself on that subject, and he (Mr. Clarke) thought Mr. Ball was quite right in so doing. He himself, having been invited in another society to read a paper on the subject, refrained from dealing with the question of gold, for the very same reasons. The gold mines of Southern India had been made so much the subject of speculation, that it was absolutely impossible to give any sound opinion upon the subject, beyond the simple fact that it was absolutely known now that there was gold in that district, and that it was distributed over a large area. He by no means wished to depreciate in any respect the present position of gold mining in India, but the result at the present moment was this, that although in many cases they had succeeded in getting up the necessary machinery, there was not as yet an adequate amount of underground work. The public looked only to the amount of capital which had been expended, but which had to a great extent been invested in speculations in the purchase of property, and he feared many were expecting results which at the present moment were totally impossible under practical conditions. It was necessary that there should be a large amount of underground working, before there was stuff to feed the machinery on the surface. On the other hand, there was no real ground for discouragement with regard to the future of these gold-mining operations, but very many grounds for encouragement. It was evident that the local objections that were made as to the impossibility of carrying out large operations, were totally unfounded. Both the European and the native workmen had been getting on exceedingly well; there was a good supply of labour, and better local conditions in Southern India than in many of the well known and productive mining regions of the world. As he had said in that room before, he believed the working of gold mines in India—whatever the result might be in the end, whether productive or not, and he believed most in the good prospects—was a matter deserving the most serious consideration and support of the Government of India.

Mr. MARTIN WOOD sympathised with Professor Ball in not being able to go sufficiently into so large a subject, and suggested that it might be well if some particular branch of it were taken up more in detail. The question of iron alone was sufficient for a careful paper, and that was perhaps the most interesting part of the whole subject, especially bearing in mind the enormous economical importance it would be to India to become so far self-dependent as to use it own stores of iron. A few months ago the title of the paper would have suggested most pointedly to the public mind the idea of gold mining, and the room would no doubt have been filled with eager gold seekers, and, therefore, he thought the present attendance might be taken as evidence that persons had lost faith in the prospect of finding gold to any extent in India. The reason for that must be what had been stated by Mr. Hyde Clarke, that the enterprise had been gone about entirely in the wrong way; and this was only another instance of disinclination of the public to examine the resources of India for themselves, and to take some pains to get at the facts about them. Instead of this gold mining being the subject of scientific investigation, it had been simply a matter of speculation. He had in his hand a list of the gold companies launched up to July last in England, and found that 13 companies represented a total cost of £1,675,000, which, compared with the area of land they possessed, represented £82 per acre. Besides those, there were three companies of which the names were well known, now united in the Indian and Glasgow; and taking these and some others, the total investment would be something about £3,000,000. Taking 10 of these, the aggregate capital was stated at £1,225,000, out of which the sums paid for the properties was £784,000, leaving £540,000 for working. In other words, nearly two-thirds of the amount was paid to promoters and vendors. The result was that, supposing these properties only cost £20,000 to open up sufficiently to get at the ore, it would only leave £341,000 for working these ten companies. Putting it in another way, £3,000,000 sterling had been invested, of which vendors and promoters had received close upon £2,000,000. Now, he wished to point the moral of this, which he was sure the Chairman, as an honourable survivor of the East India Company, would appreciate. Why did not the British public take the pains to see what they were putting their money into? There was a large constituency in England eager to obtain gold from India, believing, to a large extent, in the accounts published respecting it; why did not they go themselves, or send trusted agents to India, and make their investments at first hand, instead of third or fourth hand? These companies, launched in London, had been, many of them, carved out of companies in India, and the shareholders of these English companies had paid three or four times the amount they need have done if they had taken the trouble to make proper inquiry, and had gone to India to make their investments on the spot. That was an illustration of what happened in many other branches of investment in India. He noticed what Mr. Ball said about the artificial hindrances and official obstacles, which he thought he had somewhat exaggerated, for at the present time there was every disposition to afford facilities for the development of Indian industries. Speaking of gold, with due respect to the scientific caution Mr. Ball had shown, he thought some persons would be inclined to express disappointment that he had not gone a little further. Having, himself, been in India long before the speculation about gold arose, he knew it existed there; and gradually, having read most that had been said about it, he came to the conclusion that there must be gold there, but the question was, how deep was it down, and how long would it take to get it? Professor Ball having command of all that had been said on the subject, might, he thought, have given an approximate guess as to how deep it would be necessary to go. It had been said by Australian miners that there was no quartz which could be expected to yield a productive return of gold at a depth of less than 2,000 feet, and of course they knew how far, indeed, any of the present experiments in the Wynaad were from reaching even 1,000 feet.

Mr. H. A. SEVERN, Assoc.M.I.C.E., said he was glad to have an opportunity of affording some information on this question of Indian gold, having been a mining engineer, employed in gold mining, and who had, perhaps, done more work in India than any one else. He had had twenty-five years' experience in Australia and New Zealand, and his operations during that time had been entirely connected with gold and gold mining. He could not enter into the question of vendors and purchasers of land, but should simply speak as a practical mining engineer. About three years ago, he went to India for a large mining company, and had spent seven months in looking over their properties with every possible care; he examined the country, and made extensive surveys; he had made all his own maps and sections, and on coming to England plans had to be submitted to his directors. Reservoirs for water had to be made, roads to be cut, tram-railways had to be constructed; and he must say, that although he had seen a good deal of rough work in New Zealand, the work in India was not to be trifled with, particularly in the Wynaad district. It must be remembered that large crushing mills, for crushing 500 tons of quartz a week, were not to be handled like household goods; and part of the duty of an engineer to a gold mining company was to design all the plant, ship it to the nearest port, and carry it up from the coast to the scene of operations, traversing many bridges, which sometimes broke down under the weight of the machinery; for some parts of these crushing mills weighed three tons each; also to construct dams, reservoirs, and put down water-mains. He had one water-main three-quarters of a mile long, to supply a column of water 300 ft. in height; and these things were not to be done in a few days. He had been much struck with the great similarity between the auriferous quartz of India and that which he had seen both in Australia and New Zealand; in fact, so far as he could see, the quartz they were to treat was, as nearly as possible, similar in every chemical respect to the best quartz in those countries. He had seen some very fine samples indeed in various parts of the Wynaad district; and several of the lodes were from 6 ft. to 14 ft. in thickness, with a heavy strike extending over several miles of country. What they really wanted was, not to break off a little piece of quartz from the surface, as many gentlemen styling themselves mining engineers had done, seeing a speck of gold in it, pounding it up, panning it off, and washing away a few specks of gold from it, while they made a very simple calculation that, if a certain weight of stone would give so much gold, so many thousand tons of the same kind would give so many hundred ounces of gold; he did not believe in that sort of work; what they wanted, which would take, he believed, another eighteen months, was to get 500 feet below the mean level of the country, and there pick up the quartz lodes, when they would have plenty of backs, and then see what it would produce. He was as certain of getting payable gold in India as he had been in working some of the mines in New Zealand. The country presented difficulties, and the prospects had in many cases been grossly over-rated; many people seemed to have expected that if they only put up immense mills they could take sovereigns out of them, but this was not to be done. Gold mining and crushing operations were not to be learnt in a few months; it took a regular apprenticeship, like any other business. If he were to get a man who called himself a mechanic to manage a large crushing-mill, without previous experience, he would not in the least know how to carry it on; mercury and various other chemicals used in the extraction of the gold, and the proper method of working them, could only be learnt by experience. As a practical man, he could hold out great hopes, but they must get to a greater depth than they were working at present.

Dr. NORMAN CHEVERS said there were in Bengal two great rivers, called the Soane and the Soneamooky, whose names signified they were golden rivers, but it was a singular thing that though he had been through the district, and conversed frequently on the subject with his friend, the late learned Dr. Oldham, the head of the Geological Survey, he could not find from anyone that gold had been found in that great district within any record or memory of man. The remarks which had just been made, however, would lead him, in connection with the traditional names of this district, to think that further scientific search in that direction might be useful.

Mr. HENRY TAPP said he came expecting, from some experience of Professor Ball's writings, to have heard a brighter and more cheerful picture of the mineral deposits of India than had been given. He had had 11 years' experience in India, had travelled from the Himalayas to Cape Comorin, and also in Ceylon; he had tested its geological formations in all possible places, and throughout all his travels in India he was inclined to think that Mr. Ball had hardly done justice to the vast quantity of mineral deposits which existed there, with the exception, perhaps, of iron and salt. The subject was no doubt very difficult to compress into one paper, and perhaps if the author had devoted his attention to one or two topics he endeavoured to hurry through, he would have given a better insight into the subject. Though referring to pottery clays, he had ignored silica altogether. Now, he found enormous deposits of silica in the Wynaad in conjunction with the quartz refuse. He could quite understand why the subject of gold in India had been shirked; but he was very glad to see Mr. Severn, whom he had met in the Wynaad. He had been engaged in mining for eighteen years in Australia and India, ten years of which he had devoted to trying to develop the mineral resources of the country, and he had written repeatedly in the Indian Press, urging upon Government to develop these mineral deposits. In the North West Provinces there were enormous lodes of galena, rich in silver and in gold. The gold industry in India had been almost crushed by the adventurous spirit of speculators, who had put properties upon the London market which had no right to be there, and it was those companies which had brought discredit upon the whole thing. He had known three and four times the amount mentioned by Mr. Wood paid in Australia for similar blocks of land, which had paid well for the purpose. Seven years ago in the Wynaad, he met Sir Andrew Clarke, when a portion of quartz from the Alpha reef was taken in his presence, which contained several ounces of visible gold, now in the Calcutta Museum; and he thought if that Society would move the Government to allow those splendid specimens of Indian gold which were now exhibited to a few natives a day in Calcutta, to be transferred for a few months to the South Kensington Museum, the British public might see what was the real character of the gold existing in the Wynaad.

Mr. MARTIN WOOD thought the last speaker had missed the point of his remark, which was to the effect that these properties might have been obtained, by taking a little trouble in India, at one-third or one-fourth the sums which had been paid in London.

Mr. SOWERBY had listened with great pleasure to the paper, and, as he happened to know a great deal of India and its mineral resources, he might add a word or two upon it. The goldfields were no new discovery; they were perfectly well known to exist in the Wynaad district many years ago; and when he was there in 1862 or 1863, he obtained samples which were still in his possession;

those specimens were obtained by washing, but people would not then believe that gold existed to any extent, besides which it was then a dense jungle. Since then the country had been cleared by coffee plantations, so as to facilitate explorations. As to the extent of these gold reefs, his own belief was, from what he knew of that part of India and Hyderabad, that they were much greater than people had any conception of. The range of Ghauts, which are Plutonic rocks, and which formed the western coast of India, ran nearly north and south, sending off shoots and branches to the eastward, and whenever those branches were crossed by quartz, mineral of some kind or other had been found. He had found specimens of copper, silver, and lead, extending as far as Hyderabad. When he was there in 1875, he tried to obtain a concession from the Nizam, but he would not grant it, on account of the difficulty which existed officially for granting concessions in any native State. With regard to the other resources of India, iron for example, he had seen most of the iron fields of India, in fact, he was the engineer employed to erect the ironworks in Kumaon, in 1856 to 1857; the reason they did not succeed was the delay and difficulty of getting machinery there, and although they made very good iron, it was at a price which would not leave a profit; the iron was, in fact, too good for common use. They had nothing but charcoal fuel to work the blast furnaces, although he believed there was coal in the district. The iron resources of India were enormous. In a huge country like India, the extent of the mineral resources were totally unknown, and could not for many years be explored, but they were immense. This might be illustrated by a reference to the discoveries made in our own country within our own memory. He remembered when there was not a ton of iron manufactured in the Cleveland district, and yet now the whole appearance of the country was changed by iron works, seven millions of tons of iron ore being used up annually. At the foot of the Himalayas he had seen beds of iron 50 feet thick, and as to coal, he had no doubt that if borings were made in many parts of the country, there remained much to be discovered. He could point to one place in Broach, the Punch Mahula, and in Kattywar. Coal had never yet been known there, and yet he knew there were then seams of coal passing through that district, but no borings had ever been made to prove the nature of the strata in that basin. Again, as to the development of these resources, the great thing required was cheap railway communication. The Nizam, for example, had never attempted to develop the coal in his district, because, when the Government made a railway connecting it with the main line going to Bombay, it cost from £9,000 to £15,000 a mile, and, of course, it did not pay its expenses. Consequently, the Nizam had never extended the railway system for fear of the great expense. In any system for the development of coal, it was of the utmost importance that the railway system should be made exceedingly cheap. With regard to the proposition of Mr. Ball for having large ironworks worked by the Government, he very much doubted if such a thing would succeed. Not only in this country, but in every other, Government works were carried on in such a perfunctory way that they did not yield a profit, such work were always better when left to private enterprise; but if there was one kind of mining that the Government might carry out at a profit, it was the development of the gold-fields. If these gold mines were taken in hand by the Government, and properly developed, and the same amount of scientific skill brought to bear on them as on the manufacture of opium, the revenue from the production of gold would be sufficient to do away with the opium traffic altogether, which was a standing reproach to the Indian Government; besides, convict labour might be largely employed on the rougher work in the mines. He had lately had an opportunity o comparing the gold reefs of the Wynaad with similar deposits in Spain, and he found them almost counterparts of each other. Although Mr. Severn had spoken of the necessity of getting at the deep veins of gold, he still thought there was a great deal to be got from surface washings. They knew that 80 per cent. of the gold of the world was got from alluvial deposits, and not from reefs. In California it paid very well to wash gold when it produced from 10d. to 1s. per ton, and in the whole of the country, from the Ghauts down to Beypore, he believed gold would be found. It was often found on the beach, and in the low country, down below the Ghauts, there were numerous pits where gold had been taken out from time immemorial.

General MACLAGAN, R.E., thought the meeting had every reason to thank Mr. Ball for the comprehensive paper he had given. It was quite true that certain matters had not been gone into in detail, but it would have been quite impossible to do so without omitting a great deal which had been referred to. Something had not been mentioned, as for instance, Dr. Oldham's investigation into the existence of coal in the Punjaub, but that, perhaps, was not of sufficient importance to be referred to, though he had no doubt that in the future its importance would increase. Dr. Oldham found that, although the seams were of considerable thickness at one end, they thinned out as they approached the Indus, and disappeared, and at present, the quantity was not sufficiently large to pay for working; but when railways came nearer to it, it might assume practical importance. He mentioned it to show that there must be numerous subjects in such a very extensive field which must have been passed over. It was also very interesting to have such an eminently practical subject as this relieved by considerations of historical interest. Mr. Ball had mentioned the inexhaustible stores of salt in the Punjaub, and it was interesting to notice that, more than 2,100 years ago, these immense stores of salt were mentioned by one of the historians of Alexander, who noted that the great king of that locality derived a large portion of his revenue from this salt, exactly as the Government of India did at the present day. Reference had also been made to the petroleum of the Punjaub, and Mr. Ball mentioned what Mr. Lyman did there, the result being somewhat discouraging, though the oil collected there was now being used for gas. From the way in which it was collected, the amount could not be very large; it was generally found floating on pools, from which it was skimmed; but since the gas works had been established, pits were dug, in which it was collected. This was the same plan adopted in Burmah, where wells were dug, from which the oil was taken at intervals as it collected, and he believed there was a likelihood of a greater supply being found in a certain part of that field later, because, though the rocks had been much broken up, no deep borings had been attempted. The existence of this oil had been known for many ages, and the natives used it for various purposes, but not for lighting. It was employed for galled camels, and in Burmah it was used for various cutaneous affections. There was an interesting historical mention of the existence of this oil 800 years ago, in a Mohammedan historian's account of a great battle which took place on the banks of the Indus, near the place where these oil-fields were. In that battle, certain fire missiles were used which greatly alarmed the elephants of the Hindoo king, and many persons had supposed that here was an indication of the early use of gunpowder. But it so happened, that some of the historians of the time distinctly used the word naphtha, and it was now quite accepted that what really happened was that fire-balls, prepared with this petroleum found on the banks of the Indus, were used by this Mohammedan invader.

The CHAIRMAN, in proposing a vote of thanks to Professor Ball, said he, like every one else, had listened with very great pleasure to the paper, but he was inclined to sympathise with one or two speakers, who said that they regretted Mr. Ball had not gone more into detail with reference to certain subjects. He had undertaken, in the space of an hour, to give a summary of the history and present condition of the whole of the mineral products of India, and he had very well accomplished his task; but if he had entered into detail with regard to the mode of seeking for gold, the various seams of coal, and many other questions, which were, no doubt, of great interest, it would have been quite impossible for him to do justice to the subject in one evening. At the outset he said that the paper was only intended to call attention to the subject, and referred to that most excellent book which he had published, in which would be found the most elaborate details. The discussion had been very interesting, especially the information given by several practical men who had spoken. Dr. Chevers had made an interesting observation about the absence of gold in two great rivers, affluents to the Ganges, whose names intimated that they were auriferous; but he thought there could be little doubt that Dr. Chevers must have been misinformed. In one of his expeditions to the country at the foot of the Himalayas, he came one day upon a half dried-up river, one of the branches which flowed into the Cauvery, and on a spit of black-looking sand he saw half-a-dozen coolies working in a little hut. He thought they were Autochthenes, not belonging to the Aryan race at all; and on inquiring what they were doing, he was told they were preparing gold. He accordingly went up, and asked to see the gold, and they brought out of the hut a shell, in which there were half-a-dozen little pellets of gold, about the size of No. 6 shot up to buckshot. This was pure gold, extracted from the sand of the river. But when the question was put whether it was worth while to work for such gold, he thought the reply must be, "Certainly not." He had on his finger the gold which was then shown, which he had had made into a ring, and that was the produce of three or four weeks' work of those men. As to the coal, when they heard a discussion about the depth of coal, and that means should be taken to find it at greater depths, he bethought himself of a cleft in the rock at Cherrapoonje, behind the house where he lived, where he could have got as much coal as he liked. In the same neighbourhood he could have got as much lime and as much ironstone as he liked within a few miles, and if it would have only paid anyone to bring the three things together, the iron manufacture might have been carried on. That was no new discovery of Dr. Oldham's at the time. It had been known for hundreds, and probably thousands, of years. Mr. Ball had told them that many of these things were described by Pliny and Ptolemy. This coal was used by the natives of the hills at the present time, and they made iron in the simplest form of furnaces, and scarcely better could be made anywhere. The famous Damascus blades were all made out of iron smelted in the rudest way. Again, if they thought of that great iron pillar which stood in front of the Kootub at Delhi, 22 or 23 ft. in height and 3 or 4 ft. in circumference at the base, made of wrought iron hammered out, and weighing many tons, it showed how long the art of iron working must have existed, for that pillar was considerably over a thousand years old. The mineral resources of India were endless, but the question was how they were to be worked. Were they always to take out coal from England, when they had 35,000 miles of coal measures in the country? It was not so good as English coal, but it did well enough, and if it were only worked, and more facilities were placed in the way of those who would mine for it, there was every reason to hope that a state of things would be brought about which ought to be looked for, that the great empire in the East should not be dependent on these small islands in the German Ocean for the supply of those things which it could well supply itself. Only recently, he found that India was actually sending home the material to make quinine out of, and having it sent back there for use. Other drugs also, of the simplest kind, which would grow as well in India as anywhere else, were exported at great cost from this country. He was happy to say that this was rapidly being altered. India ought to be taught to depend on its own resources, and it was very satisfactory to find so many scientific men able and willing to develop those resources; and here he could not resist the opportunity of making some allusion to the service to which Mr Ball recently belonged. It was hardly known how much that Geological Survey had done for India. There had always been geologists of some kind in India, but it was only since about 1851 or 1852 that a survey began to be systematically formed. It began under the late Dr. Oldham, who devoted a long and valuable life to the service of his country, and died as much in the service of his country as if he had been shot on the field of battle. He (the Chairman) began his service in India with Dr. Oldham, at the same station; and most of the gentlemen engaged in geological survey had been personal friends of his, so that he had had the best opportunities of seeing the work they had done. He had constant opportunities of seeing how earnestly they did it, and how much they suffered from the effects of the climate and the hard work. Those 35 gentlemen had surveyed a district five or six times as large as Great Britain; they had pointed out where coal might be found and where it would not; possibly they had made some mistakes, but they very frequently prevented others being made; they had pointed out where it was worth while to work, and where it was not; they had written a series of memoirs of their work on the palæontology of India, which were of surpassing value; the memoirs of the Institution were not to be surpassed by the scientific records of any institution in the world; but of these 35 gentlemen at least 12 had died of tropical disease, of sun-stroke, of fever, of cholera, dysentery, liver disease, or something of the kind. Many of them had been invalided; some before they had served long enough to obtain a pension. They had gone on perseveringly, and steadily carrying on this work in spite of all the difficulties and the climate. When he thought of all this, and looked at a geological map, showing what they had done and how they had made the knowledge they had acquired accessible to the world, he felt that he was quite justified in making these few remarks in reference to a service which he always felt was not appreciated as it ought to be.

The vote of thanks was carried unanimously.

Professor BALL, in reply, said he had hoped that the remarks he made in the earlier part of the paper might have prevented some of the questions which had been put. He had just produced a large volume of 700 pages, in which he had given the compressed statement of the details of this subject. He was at a loss to know how he had been understood to say "that there is no prospect of coal being found in the Madras Province." General Applegarth had been in correspondence with him on the subject he had named, and the remarks he had made to-night appeared to have reference to statements in his book, and not to what he had stated in the present paper. It was quite impossible to enter into any minute details, but he was perfectly well acquainted with the whole circumstances connected with General Applegarth's discovery in Southern India. He had gone into the subject very carefully, and he might say that it was from respect and admiration for his energetic work, actuated by the hope of finding coal, that he had hesitated hitherto to place on record what he believed to be the whole facts of the case. But as he had been challenged now to state what he knew about it, he felt compelled to record his belief that General Applegarth had been unfortunately the victim of deception. As to the depth of the borings, to which reference had been made, no matter how much deeper those borings were carried, the same result must have been obtained. Having bored through the sedimentary, and come upon the older primary formation below, it was quite safe to stop boring, for there was no use in going any deeper; the mere mention of so many feet, without reference to the actual strata passed through, conveyed no information whatever. He had no animus whatever in the matter; it was many years since he met General Applegarth in India, and he had always been willing to give him the utmost information in his power. Dr. Oldham's opinion was, that although the coal found by General Applegarth was taken out of the ground, it had been put there first. He had not been on the spot himself, but depended on the authority of those who had been there. It was only a short time ago, that General Applegarth had written letters in the Madras papers on this subject. It and similar supposed discoveries had already cost the Geological Survey Department a considerable amount of labour, and with the general public, who were willing to believe anything against a Department, it was for a long time the cause of its occupying a very unpleasant position in India. The matter had been most satisfactorily investigated years before those borings were made, but still it was not allowed to rest, and was even now brought up again.

General APPLEGARTH asked leave to state that as soon as Dr. Oldham announced his belief that the coal was put there for him to find, he made the distinct statement that he saw it taken out by the sappers under his own eye.

Professor BALL said, in reference to Mr. Wood's remarks about the especial value of the iron deposits in India, a great deal of information on the subject would be found in his book. As to the treatment of the gold question, even the Chairman seemed to think that in that respect he had not said all that he might have. But it so happened that he had come in contact with certain gentlemen who had reported upon the gold districts of Southern India, and from what he had heard from them, he was satisfied that some of the statements and reports which had been made by mining engineers, more or less properly so called, had been undoubtedly untrustworthy; there had been some notable exceptions, and he believed they had in that room that evening in Mr. Severn a notable exception; for as far as he knew of him by reputation, he was a gentleman distinguished from others who must have reported absolutely against their consciences. Certain reports had been published which not only were not true, but could not possibly have been true; they were, no doubt, very well paid for, and more acceptable than the so-called gloomy reports, and very large sums of money had been expended in consequence. That being the position in which he was—not having had personal experience of the southern regions—he felt he could not justly speak with confidence on some of these points. As far as the evidence was firmly established, he had given it in full in his book; but as for entering into the question of values of particular reefs, or the depths at which most gold would be found, in the present paper, it had been fully recognised by General Maclagan and others, that it was not within the province of such a paper to do so. With reference to Dr. Chevers's remarks as to certain river's names denoting that gold was found in them, he could state, as a fact, that in many instances rivers so named did contain gold; one which he had mentioned, the Soane, was known to do so. Mr. Tapp seemed to think he had given a gloomy opinion of the mineral resources of India, but it was certainly not his wish to have done so, and he must apologise if he had in any way left a gloomy impression. His intention had been to state that there were good grounds for hoping that the development of the resources of India might yield profitable results. It was not his practice, to use stronger terms than the occasion required. It was very easy for people to use extravagant language about things which were matters of uncertainty, an instance of which he had given in the paper, but it was not his desire to do so. He was well acquainted with Mr. Sowerby's work in India, and had endeavoured in his book to do justice to it; but he did not believe that any coal to be found in Kattywar was likely to prove of value.

ERRATA.—In Mr. Tylden Wright's speech in the discussion on the Channel Tunnel (ante p. 568, col. 1, lines 14 and 15 from bottom, *for* It simply meant an outlay of £520, *read* It simply meant for a tunnel 14 ft. diameter, an output of 520 tons per day; line 5 from bottom, *for* £20,000 *read* £50,000.

ADJOURNED ORDINARY MEETING.

The adjourned discussion on "The Channel Tunnel" was resumed on Monday evening, the 24th inst., at 8 o'clock, the chair being again occupied by Lord ALFRED CHURCHILL.

Mr. E. A. COWPER said—My name having been mentioned by Lord Dunsany, I take the liberty of saying a few words, partly in explanation, as it may be that some here present did not see my letter of the 16th of February, in *Engineering*. Now, I have not yet heard any sufficient reason urged for the making of the Tunnel; and it seems to be taken for granted that all passengers will go quietly through this tedious hole, rendered dangerous by sluices for drowning it out, sulphurous vapours to be ready in immense volumes for suffocating all who may be in it, and electric wires and batteries to let off the dynamite mines, with which it is to be well provided, for being blown up. Now, electric wires are apt to be very fidgetty and cranky at times, as witness the big gun that went off the other day at Shoeburyness when not intended (as it happened, there was nobody in front of it, or all London would have heard of the wicked wires). Look at the experimental torpedo that was to have gone off in the lecture-room, before Royalty, but would not, and then after the lecture, went off when it should not. Instruments of this sort, that are not used every day, are not certain to do as they are wanted at a moment's notice. The Stowmarket explosion of gun-cotton was not expected, and was inexplicable. Then it is assumed that goods would all go by the Tunnel. Now, as the cost would be greater than by ship, why should they? They do not get sea-sick, and are not in such a hurry as passengers, and although a few samples, and very valuable goods, might go by the Tunnel, the immense quantities would not, as the facilities now are so great for their crossing by steamer; thus, the General Steam Navigation Company will take goods to Dieppe in 10 hours, and on to Paris in 8 hours more, or altogether well within the 24 hours. Then, again, Messrs. Gaudet Bros. load their steamers (built on purpose for going up the Seine) at a London wharf, and run close up to Paris, without breaking bulk at all, or shaking, as on a railway. Iron and coal, and all heavy goods, of course, would go from port to port by ship, which is much the most economical means of conveyance. One gentleman, who is strongly in favour of the Tunnel, says, "If an enemy had the sea, all troops and supplies needed could be brought over as well by sea as by the Tunnel." Now, if a tunnel were of no possible service to an invader, what particular good could it be to the public? But I do not agree with Colonel Beaumont in this view. Again, is there a good certainty of large dividends for those who sink their millions under the Channel? Certainly not; and I do not believe anyone who comprehended the work at all, would recommend shareholders to put a sixpence in it with the view of profit. It has been urged that the Tunnel is to make all men brothers; and Cobden talked about England and France being married by Free Trade; but I, for one, should rather object to either relationship with parties who will not even accommodate a little to get a treaty of commerce, alike good for themselves and this country. I do not believe in England giving up her nationality and independence, and becoming a mere peninsula of the Continent; it would no longer be the England it has always been—England that has maintained her independence and power partly through being blessed with a good, deep, and wide salt-water moat. Englishmen and Frenchmen are industrious and clever in different directions, but I should be sorry to see the stability of the English character changed by being mixed up with French manners and customs. But I must confess to having been led away somewhat from the point I was about to allude, owing to the first half of Sir Edward Watkin's paper dealing so largely with such considerations as I have touched upon. Now, with regard to the facts relating to the stuff that the Tunnel would have to go through, I am sorry I could not gather from the gentleman who said that grey chalk was very good to tunnel through, whether there had been any borings in the bed of the Channel to anything like a reasonable depth? I know there have been borings and shafts sunk on the shores, and on the English side a heading driven to low water mark, but, as I am informed, there have been no borings in the Channel, *i.e.*, between low water marks (and no doubt it would be very difficult to make them, if it were even possible); but then I want to ask Sir Edward Watkin, or the gentleman who spoke to there being just one line of chalk fit to go through, how is it known that there is just that line under the Channel? There may be, and there may not be? If, however, the condition of the chalk were exactly the same on the two sides, in addition to apparently being the same material (and I presume it has been analysed and examined microscopically), then there would be a greater chance of its being the same below the Channel; but the Channel may have been formed by the chalk being carried away from the level, at which it may have lain, or it may have sunk to just the right depth as we are told it has; but it is unfortunate, to say the least, that there is such a great difference between the condition of the chalk on the two sides, for the dryness of the chalk through which the heading has been driven on this side, is varied on the other side by springs, some of about twenty to thirty gallons a minute, as I am informed. I need hardly say, that if anything like chasms or fissures of six inches or a foot wide, were met with, and the water came in with the 300 or 400 feet "head" that there would be, the men would be simply washed back, and they would never see that face again. A man was once killed in a mine in Westphalia, by a drill blown out by water. In the Thames Tunnel it was different. I well remember going into the "Shield" during the construction of the tunnel, and I took some stuff out myself, the water at the time pouring in from some leaks at about 200 gallons a minute; but when the water came right in, and washed the men and Sir Isambard Brunel out (and he swam out to the shaft when there were only a few feet of air left in the tunnel above the water), the bottom of the river was simply renewed, and the great funnel-like hole was stopped up with many barge loads of clay, and the tunnel was driven through that. This happened several times. Now, the bottom of the English Channel cannot be renewed, and a tunnel or heading drowned out would have to be abandoned. Now, I have been experimenting on a good, sound piece of grey chalk, and I find that, with a very few feet head, the water comes through eight inches thickness at a very considerable rate, so that the Tunnel must be lined water-tight as made, or else enormous pumping power would have to be applied, and a very large drain be left at the bottom of the Tunnel to let the water run back out of the Tunnel of itself, to be pumped out. There is one point upon which a word ought to be said, viz, the question of making the two halves of the Tunnel so true, that they should meet exactly; now, they could well be kept to a given level at a given distance, and if they form an angle one with the other, they are sure to meet, as two sticks are when you cross them; that is the way that has been designed to make the two halves of a long tunnel meet somewhere, and it is a very ingenious arrangement. It has been stated that samples of the material found at the bottom of the Channel have been taken, but as this bottom is scoured four times every day by the tide, I do not think that even a sure indication of what is some hundred feet below the bottom. In one thing I agree with Sir Edward Watkin, and that is, that in order to be sure of keeping one Tunnel open, two would have to be made. I understand it is proposed to use a lift, and wind people up and down in shafts, as in a coal-pit, but I think most gentlemen, and all ladies would object to being slung over a pit 380 feet deep, and then, again, wound up on the other side; indeed, the sensation is never pleasant, as it produces a slight pressure, or relief of pressure, in the ears. I may say that I, some years ago, showed in various ways by which I hoped to be able to make this end of the Tunnel safe, if ever it was constructed, and I entirely failed, as Lord Dunsany told you last evening, for I could not satisfy myself at all. Dynamite any where would be so highly dangerous that the Tunnel would be useless for passengers; sluices would take a long time to open, if they could be opened at all; they stick very badly indeed, if not often opened. The proposal to have two or three 6-inch sluices is simply ridiculous, as it would take from four to six months to fill up the Tunnel; of course, several sluices of 6 feet diameter would put some water into one end of it pretty soon, but such sluices are not opened in a minute, and often stick. A strong garrison, changed every eight hours, and always constantly on the watch, and ready to fire heavily into the station, might be a slight protection, if in a very strong fort; but, as they certainly would not be sharply on the alert at all times, it would not produce anything like safety, and would require, at once, an increase in our army, to supply a force outside the fort as well as in it. Sulphurous vapours have been suggested, but whilst the gases were being prepared and made, the enemy might be pouring through, and would soon stop the gas-making. There are no absolute means of making the Tunnel safe, and preventing its being utilised contrary to the interests of this country; we must therefore keep all invaders by land, as well as by sea, out of the country. It has been stated by one advocate of the Tunnel, that foreign navies are sources of danger out of all proportion to that from the Channel Tunnel; then I would say why add to these dangers? Increase our navy 50 per cent., as it requires to be increased, so as to surely equal any two foreign nations; this is not a new notion, but one that very many thinking men have long been urging for adoption, as our navy is far too weak, and many of the ships far too slow for the work they would have to do if we were at war. It has been said that no nation would think of going to war without due notice; all I can say is that they very frequently do, and if we only consider what was the cause of the volunteer movement, we shall remember that it was just the talk ot some French colonels who talked about coming here, as they afterwards did of going to Berlin. I say, therefore, that it would be utterly inexcusable for any Government to open such a back-door, and literally build a "bridge for an enemy to walk over," thus at once and for ever throwing away the whole value of our fleet for preventing invasion, and destroying the use of that grand and efficient salt-water ditch which has so aided us in our progress and stability as a nation. Any devices for making the Tunnel safe must depend upon an amount of human agency brought to bear on the instant, to prevent two long trains, full of men armed to the teeth, from announcing their own arrival, by shooting down every policeman, soldier, porter, or station-master in the station, and taking upon themselves the duty of working the line, and cutting all wires, &c. England strong and safe, is in the best condition to keep on friendly terms with her neighbours; whilst if England was ever weak, or there was constructed an easy means of invading her, she might be a temptation to some foreigners. England has not been invaded for hundreds of years, thanks very much to the sea, in which most Englishmen glory, but which brings *mal de mer* to foreigners; whilst every other nation has been invaded over and over again, thereby losing enormously in money and property, and suffering frightfully, far beyond the slight discomfort of a little sea-sickness for an hour, on the part of those comparatively few who cross the Channel for pleasure.

Admiral SELWYN said there had been so many bugbears raised by engineers as to the building of this Tunnel, that he could not help thinking of what must have taken place some 1200 years ago, when it was first proposed to build the original London-bridge. At that time, no doubt, the people on the southern shore of the Thames, who belonged to one division of the heptarchy, considered themselves the enemies of the others on the Middlesex side. No doubt it was questioned very much whether such a bridge could be built at all, whether it ought to be built, and if it were built, how it should be commanded by fortresses. However, the bridge was built, and no one had ever attempted to do away with it; on the contrary, bridges had increased in number. He must differ very much from his senior officers of the navy who had hitherto spoken, which of course he would not do without grave reasons. Now, in what Sir Edward Watkin had said of the position of the approach to the Tunnel, he had shown conclusively that it would be utterly impossible to conduct traffic from the mouth of the Tunnel inland, for an hour, under the guns of the fleet. Besides, the idea of an invasion through the Tunnel had now been given up; they were no longer asked to combat that idea. It was recognised that the whole history of the world was a history of successful invasion, from the first invasion of Greece by Xerxes down to the most modern invasion of Pekin by the French and English. Did the silver streak, extending the whole width of the Mediterranean, prevent Rome from conquering Carthage? or did the distance of Mexico and Peru prevent Spain conquering these countries? The silver streak was one of the after-dinner fallacies of the world. It struck him, as a sailor, that if France could invade England so easily, it would be equally possible for Englishmen to invade France at the same time, and a retaliatory invasion—a vigorous attack—might be the best means of defence, as was usually acknowledged by military authorities. But, again, if it were desired to do what Mr. Cowper had expressed his inability to accomplish, the chalk and a little acid offered a very convenient mode of generating a gas, in which human life could not exist; and it would have this recommendation, that if an invasion were attempted by the French—which he was quite sure was a groundless apprehension—it would furnish the ordinary means of suicide in France, viz., the generation of carbonic acid gas. The opponents of the Tunnel seemed to lay it down that the courage and conduct of Englishmen were to be entirely absent; in short, a lethargic sleep was to overcome the whole of the inhabitants of England, particularly the two millions which now constituted the adult male population of London, and it was evident that on such an assumption all argument became impossible. They might just as well assume that the English population had no existence. They could not seriously argue any such thing; but any electrician could show that not one, but one hundred buttons might be placed in one hundred different offices in

London, the touch upon any one of which would render the Tunnel impassable in a second, so that that was not a scare which could be entertained. Admitting for a moment the idea that this dreadful lethargy had afflicted the population, and that no one could find the button, what sort of use were invaders going to make of the Tunnel, in the way of supplies to an army which was presumed to have landed elsewhere; was the army to stick by its supplies, and to defend against the whole population of England the Tunnel, or was it to advance into the country. If it advanced on London with any force that could be assembled at a moderate amount of notice, it would have to cut loose from its base. He would not go further into that subject, because it was more a military than a naval one; but he did think that the English people would make it difficult for invaders to leave their communication with the Channel. No direful effects had resulted from the piercing of the Alps, and none would result from the Tunnel under the Channel. Assuming that some nation intended to invade England, the very worst thing for that country, and the best for England, would be any exact knowledge of the spot where the invasion was to take place, because the great secret of success of invasion always was, that no one could tell where the enemy would land. He would go further than the mere reference to the easy mode of meeting objection as to invasion, and say that this was a question vital to the existence of England as a commercial power, and therefore, not one tunnel, but a dozen, should be made. Every one knew perfectly well that the history of maritime nations had been that of their position on the path of commerce; that was true of Constantinople, of Venice, Spain, Portugal, Holland, and England. The condition of retaining that commerce and the wealth which it brought, was indubitably that there should be afforded to commerce the greatest possible facilities. The commerce of the East, which was formerly the object of jealousy of all nations, never attained a third of the dimensions of that which now flowed from the West, and nations on the Continent were becoming more and more dependent upon Western countries for their food supply. If they could measure the rate at which that commerce was likely to increase, they would then understand the importance of the fact that England was an *entrepôt* on that commerce. To retain the commerce there must be no breaking bulk, transhipments, and this enabled him to explain what seemed to trouble a great many people, viz., the existence of large harbours on the French coast, which was said were not to be devoted to commerce, nor tended for purposes of war. At the present time, wo cents. a bushel was paid to the wheat holders, order to get freights for ships which could be landed at Milford Haven or Falmouth, or other deep-water ports, and sent on through such a tunnel as this; but if it had to be transhipped it would kill the profit. Competition would set in, Americans could transport the food from the United States to a French port direct, with only one transhipment, and England would be weighted in the race. Free communication from the port of landing to the place of distribution had become an absolute necessity, and unless England could supply the means it would find itself cut out from the commerce of the world. A nation could very easily sink down out of the wealth which that commerce brought, if once the cause of it were gone. He joined heartily in the remarks of Lord Brabourne as to the progression of the human race, and ridiculed the idea that the silver streak would keep out invaders, for even the Spanish Armada, gallantly as it was resisted, was not dispersed by the English ships, but by the Providence which ruled this island; and, if any words of his could aid in strengthening the view of Lord Brabourne, he might say, altering one word of Shakespeare for the purpose: "Naught shall make us rue, so England to her God do rest but true."

Mr. De Rance said, that having known the district for some years, perhaps he might be permitted to make a few remarks. Mr. Cowper appeared to imagine that the various colours upon the map, representing the subdivisions of the chalk, were to a certain extent fancy colours which had been put for the purpose of explaining the theoretical position of the Channel Tunnel; but that was not so, as the map was simply an enlargement of the map of the French Geological Survey, and which embodied the result of numerous borings, by which French engineers had determined with accuracy the fact that the same divisions known upon the English coast were present on the French shore. The yellow colour was not a mere matter of theory: it represented the position of the white chalk from the French to the English shore. Underneath the white chalk there was the grey chalk of Kent; and in passing, he might say, that the grey chalk was the equivalent of the formation which had been described by Dr. Mantell as the chalk-marl of Sussex. Any formation of the sort was certainly not chalk of a porous character: it was chalk mixed with a certain amount of clay, and formed a natural impermeable barrier between the white and the grey chalk. The white porous chalk was the formation from which a portion of London derived its water supply. The Kent Waterworks pump from the neighbourhood of Woolwich eleven millions of gallons per day, and not only so, but the amount of water available to be pumped was far in excess of the requirements of the district, so that they were brought face to face with the fact that the upper beds of white chalk were essentially of a permeable character, and capable of yielding large supplies of water. It would be a difficult task to make a tunnel of any description through this chalk. All water, whether it lie at the surface or underground, was derived from the same source, viz., rainfall, and when they took a given district on the French shore, they found this fact, that the upper or white chalk was essentially a formation charged with water, and in sinking through that formation to get at the coal-fields of that area, it was found that the grey chalk afforded a thoroughly impermeable barrier, which kept out the water in the white chalk above from the valuable coal-seams underneath. That being so, it seemed a fair assumption to say, that if the grey chalk of France was known to keep out water from the deep collieries, it would perform the same office for the Channel Tunnel. An examination of the rain-gauges, showing the quantity of water falling upon a given area, and an examination of the quantity of water taken from chalk areas, showed that the quantity of water absorbed by the white chalk in the South East of England was a quantity varying from seven to ten inches, or out of a rainfall of thirty inches ten inches were absorbed. That gave a daily average of 400,000 gallons, and in driving a tunnel through the white chalk, it might be fairly assumed, that if the chalk was capable of receiving ten inches of rainfall by absorption, it would at least receive that quantity in the portion under the sea, and experience proved that the porous portions of the chalk under the Channel was already full of fresh water. The water permeating all the interstices of the chalk, rendered it incapable of receiving any further additions of water, but the moment the level of the water was altered artificially, it commenced to percolate through the interstices in order to make up for what had been taken away; and he thought there was little doubt that any tunnel made in the porous white chalk would draw water from a distance of at least two miles on each side, which would yield 400,000 gallons per day, so that the united quantity of water due to driving a single mile of the Tunnel in the porous white chalk would be nearly 2,000,000 gallons per day. Multiply that by the distance, 20 miles, and it was easy to see the large quantity of water that would have to be contended with, even supposing that pumps were erected at both ends, in order to get rid of it. English engineers would soon discover how to pump out that large quantity of water. It must not be forgotten that the Tunnel was not to be made in the white chalk, but in the grey chalk, and he thought Sir Edward was not far wrong when he spoke of the grey chalk being altogether impervious, and that it was a kind of Providence that it was there.

Mr. T. R. CRAMPTON said the little he had to say had nothing to do with the general policy of making a Tunnel, but he thought if the young men of the present day could not do as their fathers had done, namely, take care of the country, the sooner they lost it the better. The idea of imagining that we were to sit down quietly, and allow anybody to come through the Tunnel, was out of the question, so that it need not be considered. Sir Edward Watkin had not assumed a sufficient speed by which the Tunnel could be made, on the supposition that the grey chalk went the whole distance. His impression was, that it did go throughout, and the basis of his calculation was, that it was grey chalk, and also that it was impervious. It was assumed that the machine would cut 100 yards a-week, but with very little alteration it might be made to do double that amount; and about ten years ago a machine had been made which would work at the rate of 46 inches a minute. He had made several experiments to see whether machinery could be made to work faster, and he found that it could, and the work might be got through by a very simple process of turning the *débris* into cream, and pumping it out. It was perfectly easy with simple appliances to cut two yards forward, or even four, per hour, and to send the rubbish 10 miles along a tunnel, and then up a shaft to the surface by simply pumping it up in the shape of cream, and if so the Tunnel could be completed in a very much shorter time. The difficulty in constructing long lengths of tunnel rapidly was not to cut the chalk, but to get rid of the *débris*, and he would guarantee to get rid of any quantity. A machine of 30 feet diameter could be driven at the same velocity forward per minute as one of seven feet diameter; and as to the cost, that was, by his system, very small, when compared with the others suggested. If hydraulic power were used, no power would be lost by the transmission of the water; the same power that cut the face and turned the chalk into cream would likewise pump it to the top. His experience justified him in stating that a tunnel 30 feet in diameter could be excavated at the rate of two yards forward per hour, and the *débris* delivered to the bottom of the shaft with 500-horse power, then lifted by separate pumps to the top of the shaft; but the whole might be delivered from the face to the top of the shaft in one operation. This system eliminated all the engines, waggons, and lifting machinery ordinarily employed for the purpose, substituting only two pipes of moderate dimensions along the workings, in their places.

Colonel BEAUMONT said he came to the meeting rather to listen and learn, than to speak, hence his remarks would be entirely *impromptu*. If he understood rightly, Mr. Cowper had made experiments in chalk, taking a certain thickness, and he assumed that because he could force water through it, that afforded satisfactory evidence that an amount of water would percolate into the Tunnel; but the two things had nothing to do with each other. Mr. Cowper should have taken, not a definite thickness, but an indefinite thickness of chalk; and if, in place of 10 feet or 15 feet thickness, he had taken, say, 150 feet thickness, which was the amount above the Tunnel, he would find that no water percolated through; indeed, were it otherwise, the coal measures which had been referred to by other speakers would have been flooded. Mr. Cowper had rather ridiculed the idea of a statement which he (Colonel Beaumont) had made, that the Tunnel could be protected by three 6-inch pipes against the advance of an enemy, and he spoke of 6-feet mains being more appropriate than 6-inch. Now, he distinctly adhered to his statement, that the

6-inch mains would be amply sufficient to protect the Tunnel against the advance of the bravest men in the British or any other army. If he remembered rightly, Mr. Cowper spoke of a man having been killed by a drill which was driven by a jet of water one inch in diameter; he could quite believe that to be possible, and if one inch of water would kill a man surely three 6-inch pipes would be sufficient to prevent the advance of any number of men, however great they might be, into the Tunnel. He could entirely endorse the remarks of the last speaker, that twice the speed might be got out of the machine with which his and Captain English's names were associated; up to the present, the works had been entirely of a tentative character, but before the heading was completed, the machine would, no doubt, be worked at the rate of two to three yards per hour. The difficulty which Mr. Crampton foreshadowed of removing the dirt was purely imaginary. It might have existed when men and horses were only at their disposal; but now, with the aid of compressed air engines, they were able to shift material underground, in the same way that they could aboveground with steam-engines, but without giving off any noxious vapours. Upon the last occasion, Mr. Tylden Wright pointed out, quite justly, that the total amount of matter which they had to deal with amounted to no more than a quarter of what they at present had to move at many large collieries, so that there would be no difficulty whatever in getting rid of the *debris*, and in carrying in sufficient materials for lining the Tunnel when proper arrangements had been made for doing so. Upon the military aspect of the question, he thought many had been wandering from the object for which the meeting was called. It was not so much to discuss the practicability of the question, though, not so long ago, it was looked upon as a thing which could not be done. Now, no one dreamed that the Tunnel could not be made, but all that was said was that the work ought not to be done. It was impossible in the short time at his disposal to enter into a long argument upon the question, but he thought when the arguments of the people objecting were boiled down, that there might be a residue of something, but that something would be very small. He was free to admit, that did he think the construction of the Tunnel was likely to be a source of danger to the country, he should be the first to say that the Tunnel ought not to be made, but as an engineer having some experience, and having served twenty-five years in the army, he was perfectly certain that the existence of the Tunnel would not add one iota to the danger for invasion. The advantages which the "silver streak" might afford, would not be altered in one iota by the construction of the Tunnel. When the Tunnel was made, they would have all the advantages of a connection with the Continent without interfering in the slightest degree with their insular position. The argument of the objectors came to this. Is it possible, in time of war or necessity, to take such precaution as that the Tunnel should be destroyed, and that without affecting its permanent stability. In answer to that, he might say that, in addition to destruction by water or dynamite, they could blow up the approaches at forty or fifty different points, in such a manner that it would take six months at least to repair it. No doubt the opponents would say it must be destroyed so that it would take twelve months, and if that was done, they would say it must be destroyed so that it could not be built again. But before you could argue on such a basis as that, you must assume that all our manhood and energy was gone; for after a six months' occupation of the country by an invader, it would matter nothing to us whether the Tunnel were in existence or not.

Mr. WITHERS thought the discussion had rather wandered from the point. If the ratepayers and taxpayers of England were asked to subscribe the funds requisite to make the experiments, which, under the energetic management of Sir Edward Watkin, were now being made, to see whether such a tunnel was capable of construction, he could understand that Mr. Cowper's argument against it would be well received; but what was the fact? The people of England were not asked to risk a farthing in this enterprise. Sir Edward Watkin had appealed to the shareholders in the South Eastern Railway, whose interest it was to promote the greatest amount of communication between England and the Continent, in which point their interests were identical with those of the whole nation, and they had done it at their own risk. The experiment was now being made, and how any gentleman, with the name of a civil engineer, could stand up and say that it should not be made, because it would cost too much, he could not understand. He did not see how an engineer could object to experiments; their business was to make experiments, and, in fact, they were an experiment themselves. At one time we had no engineers, and if they were not to make experiments for the benefit of the community, they were of no use at all. On the previous occasion, he came not to hear anything in favour of the project, because he had already heard a great deal about it, but in the expectation of hearing from the opponents why it should not be made. After listening to Lord Dunsany and Sir John Hay, and authorities on the opposite side, he had gone away greatly disappointed; because the argument of Lord Dunsany, when boiled down, simply amounted to this—that he had been bitterly disappointed, and so had all the dreaming enthusiasts which had originated the Exhibition of 1851, because wars had not ceased out of the world, and the millennium had not arrived. All he could say was this, that if Lord Dunsany expected in the short course of thirty years that human nature would be so changed, his opinion, measured by his opinion on that occasion, was not worth much upon the present occasion. Thirty years was a great deal in the life of anyone, but it was not much in the life of a nation, still less in the life of the world; and how any reasonable being could expect that in thirty years human nature would be so changed that wars should cease, and the millennium arrive, he could not imagine. Christianity had taken nearly two thousand years, and had not yet accomplished its object; but to Him in whose hands we all were, one thousand years was but as a day. If we were not to go on progressing in intimate commerce with great nations, we should deserve the greatest scorn which could be heaped upon us; we must wait patiently, work energetically, and trust to Providence for the rest, and it was sure to come. Now what said Sir John Hay. The pith of his observations came to this, that the Channel Fleet, as happened in Lord Nelson's day, might be ordered to the West Indies, or some other station, and during its absence England might be at the mercy of some other naval power; England might lose command of what had been called the "salt ditch," and if it did, and we were at war with the French at the same moment, for the two things must go together, the French might land an army, take possession of the English end of the Tunnel, so as to keep up their supplies, and then they would take the Bank of England, so as to indemnify themselves. All this appeared to him a sort of thing that old ladies in country towns over a cup of tea might talk of, but he did not expect that British officers would talk in such a fashion to British tax-payers who paid them to defend the nation. Such was the only kind of argument used by these two gentlemen; though he gave them credit for sincere opinion, he contended they were altogether on the wrong basis; the way to keep out of war was to get to know all you could of each other, to trade freely with each other, to have speedy transit, as little bother of transhipment as possible, no difficulty as to transport, and to have free intercourse, to break down national and insular prejudices, to be so dependent upon each other that when the uttermost ends of the earth were brought together by railways and telegraphy, that these wretched prejudices which existed in the days of their forefathers would be abolished, and altogether forgotten. He had been told that two eminent military authorities, who occupied high positions at the Horse Guards, were against the scheme. He would not name them, but they might be identified in this way—that they had never agreed upon any other subject at all. When they differed, of course one was in the right, and the other in the wrong; but on this occasion, as they both agreed, all he could say was that they were both in the wrong. He thought when England feared the piercing of the Tunnel which would connect her with France, that moment she exhibited symptoms of decadence. There was nothing so easy as to pile up the agony of alarm; but England had done her fair share in war. At the present moment France was not afraid of the Tunnel being made, because she was urging it on. France had not been ruined by the English having gone there, nor had she by the entry of the Germans into her territory; in fact, at the present moment, she was much better off than her conquerors, because she was more powerful and independent, while Germany was suffering from the tide of emigration to avoid the conscription, which Bismarck, in his iron rule, demanded of her. Although the Exhibition of 1851 had not produced very great results, still it had produced good results, and International Exhibitions, which had now been held in most of the capitals of Europe, had had this result, that they enabled the artisans of every country to see whether they were being beaten by their competitors. One thing he was sure of, and that was, that English designs had greatly improved since the holding of the first Exhibition, and it was one of the glories of Prince Albert that he had initiated such an Exhibition. The mission of man was to overcome geographical obstacles which were placed in his way. At one time oceans were looked upon as an enormous difficulty to navigation, but now they were freely traversed. Not only these physical and geographical obstacles had to be overcome, but a nation had to break down the wretched barriers which at present existed, and, by the energy and power of England, the English language was going to be the commercial language of the whole world. In conclusion, he might say, that the promoters of the Tunnel had been accused of sordid views, and that they were going to risk the safety of their country for a few thousand pounds of profit. So far from that being the case, the chief men in the matter, who had taken over a thousand shares in it, intended, if the Tunnel were constructed, to offer their shares to the Government, so that the nation might have the benefit of the undertaking—if it was a success; but if it turned out a failure, the persons who promoted the scheme would lose their money, and not the nation. That being tbe position of matters, he thought the charge of sordid views might be hurled back with all the scorn with which one was capable.

Mr. Wm. Low, as one of the early promoters of the Channel Tunnel, said he had been connected with the project for nearly twenty years, and if one thing had surprised him more than any other, it was the apparent alteration in the opinion of the general public, with regard to the practicability of this great undertaking. At first, few would believe that such a work could be accomplished, and if it could be, it certainly would not be done in their time, and such was the prevailing opinion until a short time back. What is the opinion now? The work can be done very easily—in a short time, and at comparatively small cost. This change in public opinion was due entirely to the energy and foresight of Sir Edward Watkin. It was the practical work executed by him at Shakespeare Cliff Dover, that has solved the problem. Sir Edward conceived the idea of commencing to drive in the grey chalk, where this bed is seen along the side of the South Eastern Railway, and driving a heading so as to follow the bed downwards; this heading was seven feet in diameter, and had been driven for nearly a mile by Colonel Beaumont's boring-machine. It had proved how easily, quickly, and economically, the work could be done; and at the same time proved that the grey chalk was perfectly dry under the sea. The practicability of the work and freeness from water under the sea, whilst in the grey chalk, no longer rested upon simple opinion or belief, it was a demonstrated fact, so far as the heading had been driven, though it cannot be said to be actually proved under the whole width of the Channel, until the heading has been driven from shore to shore. Some fourteen years ago, he had the honour of laying the Channel Tunnel plans before the most eminent Englishman now living, and pointed out what was proposed then first to be done, viz., the driving of a double heading of small area from shore to shore. The cost of the work at that time was estimated at one million; he carefully examined the plans and said, "That is a most salient point, when this is done, the construction of a Channel Tunnel would no longer be one of uncertainty, but would then become an ordinary commercial undertaking." That gentleman was the Right Hon. W. E. Gladstone. Since then he found that a single heading could be driven and ventilated by compressed air at half the cost he then estimated. All great works were liable to opposition. Witness the Suez Canal. What nation in the world had benefited more by that work than England? Yet the shipowners of this country had no faith in it at first. Even the railways themselves, when first advocated in this country, were also opposed. Some of them might have heard of the question put to George Stephenson as to what would happen if a cow got on a line. His answer was, that "it would be a bad thing for the coo." Now, some parties were very much afraid if this Tunnel were made that we should be invaded by our neighbours. His answer was, that if French soldiers were sent into the Tunnel for the purpose of invading England, it would be a bad thing for the Frenchman. A protest against the making of any Channel Tunnel had been signed by a number of gentlemen, and some persons were canvassing for signatures now; but two could play at that game, if it were thought necessary. He held in his hand a copy of an address, signed by upwards of one hundred English noblemen and gentlemen; this address was presented to his late Majesty the Emperor Napoleon III., on the 17th of June, 1868, asking his support for a Channel Tunnel. That was signed by the Archbishop of York, the Duke of Argyll, Duke of Sutherland, Earl of Denbigh, Marquis of Lorne, Lord Alfred Spencer Churchill, Lord Frederick Cavendish, Lord Ronald Leveson Gower, Right Hon. Lord Richard Grosvenor, Lord Alfred Paget, and upwards of fifty Members of Parliament, the Chairman of the Manchester Chamber of Commerce, with a host of others; two Admirals, two Major-Generals, and the Chairman of the Council of the Society of Arts. He hoped, for the honour of England, and to prevent the finger of scorn being pointed at us, that this absurd and nonsensical invasion fear would soon pass away and be forgotten, and that the works so auspiciously begun by Sir Edward Watkin will be carried on until the Continental Submarine Railway, by means of the Channel Tunnel, had been an accomplished fact, uniting the railway system of Great Britain with that of the Continent.

Mr. CORNELIUS WALFORD said he thought everything had been said about the Tunnel except the practical part of it, which related to those who were to use it; but not one word had been said as to the advantages it would be to passengers. He was one of the public who was a constant passenger between London and the Continent, and he had felt for years the want of some certain means of keeping his appointments there. When he was going to Manchester he knew that in five hours he should be there, but when he was going to Paris he never knew when he should be there in the winter season, because, admirable as the service was in the ordinary way, storms were so heavy sometimes as to entirely upset all the arrangements. Hundreds and thousands of persons on both sides of the Channel must have felt the same want of certain communication, and, as a passenger, he considered the Tunnel one of the great wants of the age. It was wanted in the interests of commerce, and if it could be made, why should they not have it? If it could not be made, there was no use in talking about it; but if it could, and people were ready with the money to do it, all practical and business men ought to help them forward, and cast on one side those frivolous oppositions which always sprang up in this country when any good work was going forward, and which were always wrong.

Mr. MARTIN WOOD thought that *Punch's* question had not yet been answered—was the Tunnel needed? With regard to the question of seasickness, that might be put on one side; the keeping of appointments, just mentioned, was of more importance, perhaps, but not sufficiently so to make it worth while to dig under the sea; the expense of transferring small packages was very little; and, therefore, it seemed to him that the Tunnel was only necessary for transport of heavy and bulky goods, and some calculations on that point might have been put forward. But in Sir Edward Watkins's paper, able as it was, any such simple calculation was conspicuous by its absence. He agreed with the political and moral reasons which had been urged in favour of the scheme, and it spoke very ill for the progress of scientific education when those who admitted that the Tunnel could be made, yet argued gravely that if made, it could not be closed at once by scientific means.

Mr. LIGGINS said all the eloquent speeches which had been made were directed to one point—the practicability of making the Tunnel, but he did not think that was the real point for discussion. The Society of Arts was not composed of geologists or engineers; it represented the public at large, who wanted to know the reason why it was so desirable to make the Tunnel. Admirable Selwyn seemed to have forgotten the time when the heights of Boulogne were alive with French soldiers, who might, but for Admiral Nelson, have landed in England, and the desolation of London might have been the consequence. The silver streak had been of use in the past, and he believed it might be of great service to us in the future. He did not share the fears of those who thought it would be impossible, if the Tunnel were made, to defend it against an aggressive army; he believed that an old woman with a truss of hay and a box of lucifers could create such a mass of smoke as would stifle any army which attempted to come through, and, therefore, it was not in that direction that danger was to be feared, but the facilities which it might afford in other ways. The advantage was talked of to ladies of going to see their Continental friends, and receiving visits from them; but he did not think they would like to travel like moles, under-ground, and Colonel Beaumont had not yet convinced him that he could purify the air with his compressed air engine. If he would purify the atmosphere of the Underground Railway, he should have more faith in the plan. They must not believe all the eloquence they heard there from gentlemen who were interested in the scheme. If they did make the Tunnel, he hoped it would be a success, but he did not think it would, for this practical reason. The whole Continent of Europe would send their goods here—not passengers—to save transhipment; a train would load with sugar in Austria and run right through to Manchester and Liverpool; that would not benefit the South Eastern proprietors, and as all Continental nations were Protectionists, they would not take our goods back in exchange; so that, practically, it would be a great advantage to foreigners, but none to England. He should much like to see the Channel Passage improved; and he was glad to say that very soon a steamer would be running (the *Invicta*) which was far superior to any which had yet crossed the Channel, in size, speed, and comfort.

Mr. NATHAN HUGHES said he was the author of a pamphlet on the subject, and the result of his reflections was that it would not be wise for a country having 50,000 soldiers to make a military road to another country which had from one to two millions of troops ready for action. If we were first to arm and train every able-bodied man in Great Britain, he would then say, let foreigners come through. He admired the grandeur of the enterprise, but he was convinced it would be a military danger to this country.

The CHAIRMAN said he had intended to make a few observations himself on this question; but as it was so late, he would content himself with proposing a cordial vote of thanks to Sir Edward Watkin for initiating the discussion on a subject which he was convinced would prove to be of great benefit to this country.

The vote of thanks having been carried unanimously.

Sir EDWARD WATKIN, in responding, said he much preferred the middle of that evening's discussion to the beginning or the end. He had not learned very much from Mr. Cowper or from Mr. Hughes, because if the views of either the one or the other were carried out logically, it would mean this, that you should never have any communication with anybody else, because someone might come and rob or murder you in spite of all your precautions. They forgot that this country had been made great by intercommunication. What would become of the trade of England to-morrow if the magnificent railway system — which abolished time and diminished space—could be obliterated in a moment? What did we depend on in this country internally? On railways, which meant quick, cheap, and unbroken transit. What did we depend on externally? On steam communication, which extended our commerce to the most distant parts of the universe. Did anybody want to stop the railways of England, or to put down steam navigation? If those two distinguished Admirals were present who on the former occasion gave them the benefit of their wisdom, he should have asked them which of them it was, if either, who, a quarter of a century ago, said to an old Admiral, who had fought at Navarino, "Sir, I hate the very name of steam." Now, these gentlemen hated the very name of tunnel, and why? Because they did not believe in the fraternity of man. He confessed with regard to the several propositions which he put forward in opening the discussion, he felt some moral encouragement. First of all, no one denied that the work could be done; nobody had questioned very much how it could be done; and Mr. Crampton had given them some new ideas on that point, for which he was grateful, showing how it could be done in half or quarter of the time. He could only say he was ready to try it. He was not wedded to a machine like that on the wall, with wheels or without; the machine he wanted was the one which would do the work in the shortest possible space of time; all they wanted was that the work should be accomplished. Then came the question how soon could it be done, and at what cost; and obviously Mr. Crampton's suggestion very much simplified that question. Then came the question whether it ought to be done, and that was purely a question of the advance of civilisation. If they were to remain isolated, always in alarm, always dissevered from the rest of the world, it would be reversing the policy of the century. But if they were to endeavour to make nations more and more dependent on each other by greater intercommunication — dispersing those clouds of doubt and difficulty which surrounded people and nations in isolation; they could not multiply too much the means of association between country and country, or do too much in any direction to make the whole world one, as the great author of mankind intended it to be. As to the possibility of stopping up the Tunnel if it were requisite, Lord Dunsany did not deny that it could be done, but he said you would be sure to forget it at the critical moment. But that would apply to every thing in life. You must not have a watchman, because he would fall asleep; you must not have an 81-ton gun on the pier at Dover, because something might go wrong with the touch-hole. And what were the illustrations the gallant admiral made use of? He said that when the Danish fleet was taken at Copenhagen, in 1801, the vessels all had holes bored ready for scuttling; but they forgot to take out the plugs, and so we took them. He had taken the trouble to go to the library of the House of Commons, and read all the despatches from Lord Nelson and Von Fischer, and he did not find a trace of anything of the sort. The same with regard to the tunnels in the Vosges. It was said that they were all mined, but they forgot to explode the mines, but the fact was there were no mines in them at all, and that was the reason they were not exploded. Those were the hobgoblin arguments they had to contend with, but he did not consider that a hobgoblin was an argument at all. He ventured to think that if they got to this point—not that there should be no differences of opinion—but that the Tunnel could be made; that it could be done easily, that it could be done soon, and at a comparatively small cost; then, that it ought to be done, and that if it were done, it could be very easily defended either by destruction or by a great many other means—the question had been much advanced. The last point he wished to put was this. Assuming that they differed whether it ought to be done, that they saw military and other dangers if it were done—was it, or was it not, in the interests of science, desirable to demonstrate finally that it could be done? He would appeal to them, as members of the Society of Arts—a Society always in favour of experiments, to say whether the experiment ought not to be made, not at the expense of the country, but at the expense of those who were willing to undertake it. He would not detain the meeting more than a minute longer, but a gentleman had handed him up a paper, in which he asked him to say why they could not have a bridge, and a number of other things across the Channel. He was for bridging the Channel, not in one, but in two ways; one by a tunnel underneath, and the other by enormous steam-boats on the top. There was no antagonism between the two. He was going to a meeting next Wednesday, as a member of the Dover Harbour Board, at the house of Earl Granville, to consider whether they could not urge on the Government, in some way, to enclose 600 acres of deep-water harbour space at Dover. Their French friends were setting the example, by enclosing 750 acres at Boulogne, and 450 at Calais. Surely we were not to be beaten in a matter of this kind, even by Frenchmen. He hoped there would be deep-water harbours on the English side as well as on the French, and then they would be able to have as good a service by sea as could be desired. He would conclude, by reading two or three lines from a letter he had received that day, from a man whom he held in the greatest reverence, a man who had nearly approached his one hundredth year of labours and honour—Sir Moses Montefiore. He had written to him, asking to be allowed to show him the works at the Tunnel, as he had already shown them to the Prince and Princess of Wales, Princess Louise, the Duke of Edinburgh, and many other eminent persons. Sir Moses Montefiore replied, thanking him very heartily, saying, that the state of his health at present would not allow him to take advantage of the offer, and concluding with these words:—"But I do hope, and I shall not give up the hope of attending the christening, and of hearing his Grace the Archbishop of Canterbury name it. I am one of those who think that every great work, and such the Channel Tunnel undoubtedly is, should bear the name of its promoter, and that no undertaking can prosper without the blessing of God." He would only say he hoped the enterprise would prosper, and it could only prosper, as Sir Moses said, by the blessing of God.

The following communication has been received from Lord Alfred Churchill, the Chairman of the meeting:—

The length to which the discussion on the proposed Channel Tunnel extended on Monday evening, induced me to call upon Sir Edward Watkin for his reply without making any observations of my own. I should be glad, however, to take this opportunity of recording my views in the matter.

As to the practicability of the scheme, there is no need for me to say anything; it is admitted by all, even by those of the alarmist section of the community who have been inveighing against the proposed Tunnel, that its construction is a possibility. I consider the completion of the project would constitute the natural corollary or sequel to the French Commercial Treaty. That Treaty, entered into upwards of twenty years since, has been productive of the greatest possible benefit and advantage to both nations. I need not enter into any endeavour to prove this by statistics; the facts are patent in themselves. There does not exist a single harbour upon the north coast of France, from Ushant to Calais, from which steamships connected with various railway companies are not running almost nightly, conveying market produce to this country. I am told that at St. Malo alone, the South-Western Company's boats are conveying market produce of the value of £3,000,000 a-year. You may observe the same degree of activity at the other ports along the coast, to say nothing of the amount of goods traffic which is exchanged between the two countries by other means. Few of those who have not an intimate acquaintance with the carrying trade of this country, are aware of the great importance it is to the exporter to have his produce conveyed with the greatest expedition and with the minimum of cost, which would result from the formation and use of a Tunnel. This would enable him to save all the cost, labour, trouble, and risk of moving his goods from truck to ship, and from ship to truck. Each one of these transactions involves risks and expense. I do not think it at all improbable that we should see through trains conveying market produce grown in France and Belgium, to the London markets regularly every morning, while the fishing interest in the North Sea would likewise send their through trains of fish to Paris and Brussels. Further, that the general merchandise of the two countries could adopt this route to save the risk and cost of transhipment.

These are simply possibilities; but the great thing to be remembered is, that by whatever means trade can be promoted, it has a tendency to cement and consolidate the relations between the exporter and the consumer. The effect of this must naturally be to increase the friendly relations between nations who adopt this principle, having as their result, the rendering of wars more difficult and more costly to both parties. I have heard that German opinion is adverse to the Tunnel; but the reasons given are different from those of the military alarmists and are obvious. The idea is, that the effect which would be produced by the making of this Tunnel, would be to cement more firmly than ever the cordiality of feeling between England and France, and that in the event of any further European complication, Germany might find she would have to reckon with both countries together, instead of with France alone, as on the last occasion. If it is true that these views are entertained by the Germans, it seems to me only a stronger argument in favour of the realisation of this scheme. I think, possibly, however, you might find that it would lead to the wider diffusion of liberal views throughout Europe. England would be far more likely to invade the foreigner with liberal ideas than the contrary. I felt surprised to observe how very weak was the opposition to the scheme, as manifested at the meeting, The fact that Sir Edward Watkin would deliver a paper upon the subject was known far and wide. Cards of invitation were issued to all the signatories to the Protest in the *Nineteenth Century*, but, with the exception of Lord Dunsany and Sir John Hay, none of the gentlemen thought it worth while to come forward to express an opinion. The military arguments against the scheme appear to me to be singularly weak, if we may judge by Lord Dunsany's article in the *Nineteenth Century*. I pass over the idea that 2,000 men, disguised as tourists, could seize and secure the English end of the Tunnel by surprise, as puerile in the extreme. The Tunnel would naturally be guarded by a fort, which would contain all appliances for rendering it valueless to an enemy, and to which strangers could not easily gain access. The only possible conditions under which an enemy could use the Tunnel for war purposes, would be in the event of his taking the Heights of Dover, and being able to force this Tunnel Fort before the various preparations for the destruction of the Tunnel could be put into operation. Should the flood-gates be opened, and the sides of the shaft blown in by dynamite, it would take a full year or more before the damage could be repaired, under the most favourable circumstances, after the conclusion of peace. It appears to me that the military alarmists are entirely on the wrong tack. Should they wish to resist an invasion of this country they should endeavour to ascertain a more probable place for landing, and take measures to defend it accordingly. On the west side of Dungeness, we possess an admirable roadstead, with deep water close in shore, and sheltered from all winds from S.S.W. to N.N.E. Dungeness is an equal distance from Boulogne as from Folkestone. It would be quite possible for an enemy to throw an army upon this coast at this place with the greatest ease, and I think that if these military men would turn their attention in this direction they might do some good. I consider that an earthworked fort should be erected at Lydd, and another at Romsey. These should be kept constantly garrisoned and prepared for any emergency. No enemy, landing upon the shore of Dungeness, could afford to pass these forts without taking possession of them. This would give time for our army to rally and meet them. The day that an enemy puts his foot on these shores, 500,000 men would be placed under arms, including volunteers. I merely mention this to point out where I think the danger lies. It will not be in the Tunnel, which is calculated by itself to effect every good and every blessing which Providence is likely to grant to it, by the greater intercourse amongst nations. The objection to it seems to me to be, to a large extent, one of pure sentiment. Many people do not like the idea of the country ceasing to be an island, but I do not admit that we shall in any way lose our insular character. I most heartily wish Sir Edward Watkin success in this great undertaking. It is one which in my opinion is pregnant with great benefit to this country, and to Europe at large, and the completion of it will redound not only to his own honour and credit, but to that of the nineteenth century which shall see its accomplishment.

NINETEENTH ORDINARY MEETING.

Wednesday, April 26th, 1882; the RT. HON. E. P. BOUVERIE, F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society :—

Arnold, David Nelson, Bickenhill-hall, near Birmingham.
Bradbear, J., 23, Finsbury-circus, E.C.
Brown, David, F.C.S., 93, Abbey-hill, Edinburgh.
Bury, William, 5, New London-street, E.C.
Kenrick, George Hamilton, Church-road, Edgbaston, Birmingham.

Layborn, Daniel, Dutton-street, Liverpool.
Shaw, C. J., Clifton-house, Gascoigne-road, Hackney, E.
Watkin, Alfred Mellor, Dunedin-house, Folkestone.
Wilson, John Millar, F.C.S., Birch Vale, Derbyshire,

The following Candidates were balloted for and duly elected Members of the Society :—

Heathman, J. H., 63, Long-acre, W.C.
Jackson, John Archer, Sunnyside, Hawkhurst, Kent.
Jeffreys, Edward Alexander, M.I.C.E., Gipton-lodge, Leeds.
Jenkin, Fleeming, F.R.S., 3, Great Stuart-street, Edinburgh.
Moore, Benjamin Theophilus, M.A., M.I.C.E., Cavendish-house, Teddington.
Tangye, James, Aviary-cottage, near Redruth, Cornwall.

The paper read was—

TELEPHONIC COMMUNICATION.

By Lieut.-Colonel C. E. Webber, R.E.

President of the Society of Telegraph Engineers and Electricians.

Any of my hearers who lately heard a lecture delivered by Professor Dolbear before the Society of Telegraph Engineers and Electricians, will not need that I should travel far over the disputed ground of priority of invention of the telephone in its various forms. It will be sufficient for me to remind my audience that, in 1878, at the Paris Universal Exhibition, the merits of the then two best known claimants — Professor Bell and Mr. Elisha Gray—were referred to in the following terms by Mons. le Comte du Moncel, who acted as technical adviser to the International Jury. He wrote :—

"The *caveats* of Messrs. Bell and Gray—both registered on the same day, viz., the 14th February, 1876, at the United States Patent Office—are clear and independent witnesses of the facts. In the *caveat* of Professor Bell, no mention is made of a speaking telephone before page 7, and the instrument he shows at figs. 5 and 7 (to quote his own words, published in the *Journal of the Society of Telegraph Engineers*, vol. vi., page 407) gave results unsatisfactory and discouraging. The whole of the patent, except one short sentence, refers to a musical telephone which could not reproduce speech. On the contrary, in the *caveat* of Mr. Elisha Gray, nothing is alluded to except the speaking telephone, and the description and designs given in the patent are such that an apparatus made in accordance, would communicate articulations. It is then evident," continues Mons. du Moncel, "to every impartial mind.

"1. That the two inventors had, at the same time, the idea of reproducing speech with the assistance of undulatory currents.

"2. That Mr. Gray was the first to discover the way to solve the problem.

"3. That Mr. Bell only succeeded after "trials," and these almost casually referred to in the last sentence of his claim.

"4. That the two inventors' systems are different, in that one uses a battery, while the other uses only the induced currents resulting from the use of a magnet.

"5. That while Mr. Gray was the first to solve the problem, Mr. Bell was the first afterwards to give it a practical and convenient form.

"6. That the invention of Mr. Gray gave birth to the telephone of Mr. Edison, which itself was the progenitor of the microphone."

In consequence of this carefully framed report of the Comte du Moncel, and my investigation of the evidence collected by him, the jury awarded the highest honours to the three great discoverers, Bell, Gray, and Edison.

It is just and right sometimes to touch on matters which are historical in science, because we find men forgetful of the past, even of their own statements made on evidence never contradicted, and for purposes requiring the deepest thought; for, it is a fact that, in in February last, the same well-known writer published an article in *La Lumière Electrique* on the discovery of the telephone, and bestowed all the honours, as the inventor and discoverer of the telephone, on Professor Bell alone.

It has always appeared to me that both these gentlemen, the one a physicist, the other a telegraphist, were (see their *caveats*) in search of multiple harmonic transmission, when they stumbled on one of the most marvellous discoveries of our time. Both were delayed by the difficulty encountered in trying to transmit an indefinite number of intermittent currents without destroying their individuality. Both went further, namely, to working with currents of varying amplitudes, on a receiving electromagnet, but of the two it was left to Professor Bell to substitute a permanent magnet, to which, however, he makes no reference in his first *caveat*. Their claims, that the sounds were re-produced by means of the vibrations of the mass of a diaphragm, under the influence of the changes in the state of the fields of the magnets and the electro-magnets, are now known to be worthless—and, from the announcements of Professor Dolbear in the lecture already mentioned, it appears that Reiss, years ago, forstalled, both in his use of electro-magnets and magnets, for the communication of, and re-production of sound, leaving one form of originality alone to Professor Bell, namely, the use of magnet telephones as transmitters.

But, since then, great advances have been made in knowledge, and investigations have proved that telephones can be made which reproduce articulation, without the aid of any diaphragm at all, and that the sounds are produced by the dilation and contraction of the molecules of the magnetic mass itself, and correspondingly in those of any matter in its neighbourhood. To this cause for the production of sound, has been added a calorific one, and further receivers or reproducers have been formed on the principles of the microphone and of the condenser, which act without the assistance of any forms of magnet. All these forms of telephone receivers are merely evidence that the time is close when it will be demonstrated that the whole process of conveying and reproducing articulation at a distance, can be effected in a much simpler manner than we now suspect.

So far as carbon is concerned, as a means of acting as the mediatory for the emission of undulatory currents, we may for the present rest content with what we have got. Its use is due to the discovery of Clerae, some fourteen years ago, that the electrical resistance of carbon varies with the degree of pressure to which it is subject, a discovery which is the foundation of that of all the carbon telephone transmitters.

For the benefit of some of my hearers, I will mention the chief functions of the carbon transmitting telephone common to all its forms, namely, that the use of carbon allows of stronger undulatory currents being sent to the line than is possible by the excitation of a magnet alone. The system of Mons. Ader, used in Paris, is one that has not received much attention in this country, and its success shows we are not in the least dependent on the limited number of forms as yet at the disposal of the public in this country. The transmitter of Ader has ten pieces of carbon in two contiguous series of five, carried in sockets sunk in three pieces of parallel carbon. Like the Crossley and Wollaston forms, the points of contact are multiplied by the number of these sockets. The pieces containing them are attached to one side of a thin pine wood sounding-board, so when the board vibrates under the influence of the sound waves from the voice, vibration occurs at each socket, and thus the pressure between the surfaces of the carbons varies, and the number of atomic contacts are increased and developed. Now, as these contact points are in the circuit travelled by the voltaic current used with the telephone, it is evident that the vibrations produce constantly varying resistances in the circuit, and that the electric current, instead of being steady and continuous, is divided up into a number of currents, each of which identifies itself by the varying periods of its undulations. In the other forms best known to us, viz., the Blake, the Edison, and the Hummings, there is the greatest extreme of difference in the number of contact points; and this leads one the more to believe that we are still distant from the true meaning of the work performed by the pressure of the carbon, and by the molecules of the carbon itself, and also, of which form, better or inferior results is to be expected.

The chief industry which the use of telephones has brought into existence, is that called the telephone exchange system. Previously, while the telegraph was the only means of electrical communication between place and place, the plan of intercommunication between stations, by means of a switch at a central station, was used. The Post-office used it at Colchester for the ordinary business between several small towns in that district, and between them and London; and, at Newcastle, between persons renting private lines; in the former case the Morse sounder was used for signalling, in the latter, the Wheatstone A B C instrument.

But the arrangement met with no favour among old telegraphists, who, from long habit, leant to the practice of transmitting messages at intermediate stations; thus adhering to the disinclination, in all kinds of labour, to adopt plans which replace physical means by mechanical. So long as the process of communication was by means of telegraphy, the exchange system and its advantages could not be realised; it was too complicated and expensive for general use. But the means of conveying articulate speech from one place to another produced a change, and a great industry, conducing enormously to the well-being of society, has sprung up.

Already, all over Europe, companies have been formed to provide the business world in towns with this great facility in the conduct of public and private affairs. In Paris there is a central exchange, having nearly 1,000 subscribers' lines entering it, and several branch exchanges in connection. At Lyons, Marseilles, Bordeaux, and Rheims, exchanges have been established, and their work is rapidly extending. At Bordeaux, since the 15th October last, the exchange has been kept open night and day. In France, the industry is somewhat checked by the circumstance that overhead wires attached to houses have rarely been used by the Telegraph Administration, and there is, in consequence, great dislike by private owners of houses to granting way-leaves. The Government have followed the system, especially in Paris, of placing their lines in the sewers, where they are either enclosed in lead pipes, or simply cabled and slung on hooks to the suffete of the arch. In consequence, the lines connected with the first telephone exchange established in Paris, were all carried along the sewers and subways; but owing to the difficulties produced by induction, they had to be run a little distance apart, say two or three inches, and carried in hooks, rivetted one above the other, at that distance, to galvanised hoop iron, which was nailed to the wall or arch; these supports being at short intervals, to prevent any strain to the insulated copper wire, which had to be used. I need not explain why, but will simply state that such a system, to be enduring, is full of objections to a telegraph engineer.

In Italy, the General Italian Telephone Company, and the Ligurian Bell Telephone Company, are establishing telephone exchanges in all the principal towns. At Genoa, some time ago, the exchange had over 300 subscribers.

In Belgium, Mons. Bêde, a telegraph engineer, has been one of the chief promoters of this industry. Exchanges are not only established in several towns, but these are connected by trunk-line wires, so that persons in each can intercommunicate. The subject of telephony in Belgium has already been debated in the Belgian Parliament; and although the employment of over-head wires in Brussels is sanctioned by Government, the eventual decision is uncertain.

At Christiania, a telephone exchange has been working during the last year. In Switzerland, Lausanne, Geneva, Berne, and Zurich are provided; and the last place has 400 subscribers. In Portugal and Spain, in Bavaria, Austria, and Russia, the industry has made a serious commencement.

In Germany, every large town is beginning to awake to the advantages of the system. In Berlin four exchanges are at work. Public telephone offices have likewise been opened, in which any person can converse with any subscriber on the system during five minutes, by the payment of 50 pfennings in the purchase of a subscribers' list. At the Bourse there are close padded chambers, where brokers can resort to converse with any clients who are subscribers. Taken together, Berlin, Hamburg, Mulhouse, Breslau, Cologne, and Strasburg, possess 1,800 subscribers. At Strasburg, the Administration have been instrumental in establishing the industry, by calling on the inhabitants to send in their names as would-be subscribers, and publishing the tariffs for subscriptions within the town, and situated in the suburbs, as well as for persons residing in Kronenburg, Kœnigshofen, Neudorf, and other places in the neighbourhood.

In the United Kingdom the progress has not been very rapid, considering the vast field there is for the industry, not only as a necessity, but also as a luxury; but more will be said on this subject later on.

In all our colonies, and in India, a commencement has been made; but it is when one turns to the United States—the birth-place of the telephone—that one sees the wonderful fertility of this industry. The last list of towns published by the *New York Review* of the telegraph and telephone, gave the names of 600 where telephonic exchanges were established, exclusively under the licenses of the American National Bell Telephone Company, of Boston. In New York alone there are more than 13 exchanges, with over 5,000 subscribers, besides 1,500 private telephone lines. In Washington, the telephone lines on poles are over 400 miles in aggregrate length, carrying 3,360 miles of wire, besides over 100 miles of line carrying municipal and private telephone wires. In Chicago, the exchange in the law courts is so established, that the lawyers can be summoned from their chambers as their cases come on.

An opposition to poles standing in the streets has commenced in some great towns. Anyone who has seen the disfigurement caused by these great masts at street corners in American towns, will sympathise with the objection.

There are so many other applications of the telephone, that a description of them would require far more time than one evening affords. The facility for becoming part of the audience at an opera, concert, or any assembly, is a branch of this industry which is likely to become very popular. A careful description of the arrangements made in Paris last year, for connecting the opera with a *salon* at the Electrical Exhibition, will be found in *La Lumière Electrique* of 21st September, 1881. Those who had the good fortune to listen on any of the evenings when the opera was open, will recall the startling effect produced by the solos. Every modulation of the voice and tone seemed to be perfectly rendered. It was as if the singer was at one's side; and yet there was an unearthly uncertainty as to the direction from which the notes proceeded. The orchestra and chorus, being further from the transmitters, gave a weird impression of being somewhere in the clouds, and yet all around. The fascination was irresistible, and the listener was chained to the spot, with a telephone to each ear.

The advantages afforded by the telephone, in the communication between fire-stations, railway-stations, canal-locks, police-stations, and water-companies' stations, are all incidental to the increased facility of the telephone over the telegraph as a means of communicating. Municipalities and companies are fast becoming alive to the improvement and economy achieved; and the advantage derived from the fact that any official that happens to be at the instrument can use it, is of great importance in matters of administration and supervision.

A novel application is made in the New York State prisons, where transmitters are placed in the walls of cells; from these, wires are led to receivers in another part of the building, and important conversations between prisoners have been overheard, which have assisted the ends of justice.

Telephone exchanges, that are open at all hours, are rapidly being applied to novel purposes. For instance, subscribers can arrange to be awakened, by the exchange ringing their bell, at any appointed hour. Correct time, say at noon, is sent on all subscribers' wires, by the striking of a public clock, which is heard simultaneously in every telephone on the system—one wire being carried from the exchange to the clock, where a transmitter is fixed, and all subscribers' lines connected for the time to it at the exchange.

The expression, "telephone exchange" is one rather to be quarrelled with; but it is, like so many expressions for which we are indebted to our transatlantic brethren, easy to use, and fairly descriptive—and what more do we want in these practical times? The word exchange is certainly not fully descriptive of the use to which the institution is put. In England, telegraphists have learnt to apply it to the system of radial lines which join the Stock Exchange to the offices of a large number of stockbrokers.

The system by which a large number of persons desirous of being able to converse without leaving their dwellings to meet, is one worthy of a clearer and more comprehensive title. However, for the purposes of our subject of this evening, the word exchange may be used to describe the central station from which the subscribers' wires radiate.

The expression, "*an* exchange system," will include central stations, the subscribers' stations, and lines connecting them. When I speak of "*the* exchange system," the system as a means of intercommunication will be intended.

The telephone industry consists not only in the manufacture and supply of the necessary apparatus, but in the establishment of exchange systems. These systems, in their simple form, arise out of a want, on the part of a number of householders, or business and professional people, to be able to speak to one another without leaving their houses or offices to meet. For instance, in a scattered suburban neighbourhood, covering an area the diameter of which is about a mile, or, in a thickly habited neighbourhood containing business premises, let us suppose a case in which twenty-five persons agree to subscribe the necessary funds to establish an exchange system. It is not necessary that each should require to speak with all the others; the motive on the part of each to converse with any five or six would be sufficient. A further motive would exist if the exchange could be connected with a post-office, a police-station, and a fire brigade post; more so if it had wires to a cabstand, a chemist, or a medical man. The exclusive Britisher may be at once told that becoming a subscriber to the same exchange as a neighbour is no introduction.

As an example, suppose an exchange established for the benefit of the inhabitants of the block of buildings and streets round St. James's-square, bounded by the Green-park and the Haymarket, Piccadilly and St. James's-park. In the first place, all the tradespeople and private houses would find it their advantage to be connected; mutual commerce, to the saving of time and labour, would spring up. Then, the clubs, by joining, would allow of members of different clubs to converse; and, as described, it would be much to the convenience of the neighbourhood if wires were carried to the cab-shelters, police on duty, fireman in waiting, to the telegraph office, and so on. The same description would apply anywhere else. The area of an exchange system \\ probably depend on the number scribers living within that area; after the number exceeds 500 the area should be diminished, as an exchange then begins to become unmanageable. Two exchange-rooms of 500 each, under one roof, will be situated under the same conditions as two under different roofs; but the attachment of 500 wires to one building is more simple than when 1,000 are required. The next stage in the exchange system is, when subscribers to one desire to speak to those joined to another. It is clear that they must then converse through not only their own wires to their own centres, but also through a wire joining those centres, which we will call a "trunk" wire.

The following conditions are evidently consequent. If two subscribers to the same exchange wish to talk to a third, one must wait till the other has finished. If there is more than one exchange in the same neighbourhood, subscribers' lines should lead to the nearest. If the conversation between subscribers to different exchanges is frequent, there must be several main or trunk wires between them, probably 5 per cent. of the total number of subscribers; thus permitting 10 out of every 100 to speak through two exchanges at a time.

The next reasonable result of the last-named condition will be, that some persons will subscribe to their own exchange only, and never communicate out of it; and others, by paying larger subscriptions, will have the right to speak one or more exchanges beyond. Under this latter proposal we can suppose an example, say, that an exchange exists at Richmond, with 500 subscribers, and that 100 of these pay a larger subscription than the rest, in order to be able to speak to their offices in the City. It is clear that the Richmond centre must be connected by, say, five wires with one in the City with which the 100 subscribers' City offices are connected.

One additional example, continuing on the last, will give an idea of the magnitude of the question, connected with an attempt to meet the social and business wants of such a community as London. The exchange in the City receiving the five Richmond trunk-wires would, probably, not be the one with which some of the Richmond subscribers' business friends were connected. Those individuals would have to connect their offices, by a second subscription, to the City centre most suitable to their business, and may be by a third.

The question at once presents itself, whether a great business centre like the City of London should be divided, and served by local exchange systems, or by systems with which subscribers can be connected by choice, so as to suit their business.

Let us take another example, for instance, of exchanges having been established at Woolwich, Greenwich, and Blackheath. For purely local business, the subscribers would establish their systems at each place, and would pay the minimum subscription; but supposing that 30 at Woolwich desire to be able to speak to Greenwich, and 20 to Blackheath, and 40 between the latter places, trunk wires would have to be established, three from Woolwich to Greenwich, two from Woolwich to Blackheath, and four from Blackheath to Greenwich, and the people having the right to the superior accommodation would have to pay a higher scale; and lastly, if any of these wished, besides, to communicate with a City or Borough exchange, they could do so through the direct trunk City wires which would be required from Blackheath, Woolwich, and Greenwich, on payment of a still higher scale.

The establishment of an exchange system is, in one sense, a very simple affair indeed, and only requires in the person who plans and superintends the construction, a good experience and knowledge of the business of an electrical engineer. The projector of a group of systems, to meet the present and future wants of a great city, so that the minimum quantity of work done shall have to be undone as the systems extend, and the demands of the public increase, must have given the subject deep thought, and have foresight of no mean order.

The establishment of a single system includes the selection of a suitable building where to place the switch room, and upon the roof of which to erect the cradle for the attachment of the overhead wires to the subscribers' stations. The building should be away from thoroughfares, so as not to invite too much attention. It means that the work performed in putting up the wires shall be executed in a thoroughly workmanlike and secure manner, and that, during the ordinary period of the life of an overhouse wire in our towns, they shall require no more inspection and repair than is well-known to be necessary, under such circumstances, to all telegraph engineers. It also means that the switch room shall be carefully planned, and capable of being worked with the minimum of labour, with the maximum extension of numbers of subscribers, which maximum, as I have already said, may be put at about 500. And it requires that the apparatus and leading-in wires at subscribers' stations shall be conveniently placed; in fact, it requires all the skill, care, and precaution which telegraph administrations of some standing have found to be alone consistent with a good revenue, and the want of which, in earlier days, in the absence of much experience, would have proved damaging to more than one old telegraph company, had not the State bought them up. Further, it is necessary in establishing a system, to consider the future possible, at any rate probable, wants of a district, and to bear in mind that the new exchange may have to be joined, by trunk wires, to neighbouring exchanges, even immediately after its opening, in consequence of the demands of its subscribers; and also that a district occupied in the first instance by one exchange, will, before long, require two, or three, or more exchanges, all communicating with the first one, and perhaps with one another.

There is no constructional difficulty, mechanical or electrical, in accomplishing all this by a knowledge of telegraph or electrical engineering, and by ordinary foresight and management; and there is no reason why the creation, working, and maintenance of such an industry should not be carried out at a very moderate cost to the subscribers who co-operate to establish it. But in this country, as in others, the leave to establish posts and wires has been always difficult to obtain, and the chief reason is, that in towns and crowded neighbourhoods the lines, in by far the largest number of cases, have been put up *un*mechanically, and are, in consequence, dangerous and unsightly. The result has been that, by degrees, overhead wires, which ought to be objects of interest, if not of admiration, as representing a great social and national industry, have become objects of dislike to all, and animosity to many.

Years ago, telegraphs commenced their career under a cloud, and everyone's hand was turned against them. What should have been always regarded from a social economy point of view, became a nuisance, and the poor poles and wires have never recovered the circumstances of their birth. Competing telegraph companies ran up structures which could not be described as a credit to the engineering skill of their authors, and the property of some became a byword for ugliness and danger. The antagonism thus created reacted on those desirous of improving, and the opposition became unreasonable. Opposition increased the structural difficulties, and the greater these were, the greater the nuisance and danger afterwards attending the maintenance of the lines.

I speak with a good deal of personal experience, and, with it in full view, I do not hesitate to make the following statement, namely:—Had it been possible to execute the work properly from the beginning; had the public consent been obtained by conciliatory action, and by the erection of well-planned and sightly works, the opposition to overhead telegraph wires, in town and country, would have disappeared long ago; a great economy would have been effected by the absence of indifferent and hasty work; and, when telephony appeared as an industry, the field would have at last been clear for its rapid and reasonable extension, to the great benefit of the community.

To show that I am referring to a period many years ago, I will add that the Post-office inherited the legacy of the disability I mention, which all its efforts have very partially overcome. Unfortunately, both in Parliament and out, the subject has been misunderstood. With pain one has read of one Postmaster-General after another standing up in the House, and tacitly agreeing to the assumption that overhead wires should not exist, deprecating their continuance, and expressing the intention of taking them down, thus, no doubt unconsciously, leaving the public and the press to believe that his telegraph engineers could not do better. The mouthpiece of what should be the highest authority in the land on such matters, has full justification in stating, on the contrary, that overhead telegraph lines in town and country need never be an eyesore or nuisance, if proper facilities and way-leaves can be lawfully claimed by the constructors, subject to proper precautions to protect the property of individuals from damage or detriment.

For many years the press has been unintentionally mystified by such statements as I have mentioned, but its excellent sense has prevented its supporting entirely the clamour of the discontented, more or less encouraged by the cable and gutta-percha interests.

I have thus endeavoured to sketch how the telephone industry has fallen on evil tracks, and has had to encounter unparallelled opposition to its extension. I believe much has been due to the want of experience of its promoters, an absence which has led them over many of the devious and stumbling ways of telegraphy's early days, and which has not yet allowed them to see how the whole public opposition might have been conquered, how the great aggravation of the causes of objection to overhead lines might have been avoided, and a host of troubles in the future prevented. For instance, every telegraph engineer in the country knew that the use of a light miniature material for short telephone lines, would meet all electrical requirements of working and maintenance, and reduce to a minimum all the well-known objections that only become serious when the wire is as heavy as that used for telegraphs ; but such knowledge does not seem to have been available, and a great deal of capital has apparently been wasted in lines that have been inconsiderately run up, and which will not long be suffered by weather and public opinion to remain, to the detriment of the buildings which carry them, and danger to the passers by in the streets below. We have not time now to go over the battle-ground of underground *versus* overhead lines, for "stringing" (as our Transatlantic brethren say) insulated wires, but my hearers can well understand that it is much less costly to use the air as an insulator, than to have to protect a wire from its surroundings, by means of a perishable dialectric like gutta-percha.

The simplest process for communicating between a switch-room and the out-stations connected with it, followed in many exchange systems, is, that the subscriber has the battery power at his station, with which he can send a current on his wire, and ring a bell at the switch. The same plan is followed, as is familiar to most of my hearers, namely, in that for the bells in hotels or private houses, where the current started by each bell-push passes, first through an indicator, in which a disc falls, showing the number or name of the room which is ringing, and then through a bell common to all. Similarly, the current sent by the contact-push on the subscribers' telephone, the circuit being completed, either through the earth or by a return wire, passes through the bobbins of an electro magnets and then through the bobbins of an electric bell to earth.

The work performed is, first, to attract an arrnature, which lets fall and exposes the face of a tablet with a number on it; second, to ring a bell which is common to all the circuits. Many forms of indicator have been proposed, but those which keep the number covered in its normal state, and expose the number when acted upon by a current of electricity, are the best.

The simplest form of procedure of the clerk in the switch-room is, when a subscriber rings, and the table showing his number falls, first, to take out a plug in the switch, which nominally completes the subscriber's circuit through the bell to earth, or back to his station by a return wire, as already mentioned. Second, the same hand places the plug in another hole, which has the effect of joining the subscriber's wire to a telephone at the clerk's side, which has its own battery-power. Third, the switch-clerk's telephone is so placed that he need not hold the receiver to his ear, and his hands are free ; by pressing a push, he sends his currrent back on the line, which rings the subscriber's bell in reply. Fourth ; the subscriber, knowing by this he has the clerk's attention, states what he requires, say, the number of another subscriber, with whom he wishes to converse. The switch-clerk, if the station required is not otherwise engaged, replies "through," and immediately takes out the plug connecting the caller with his own telephone, and connects the two subscribers' lines by one or more plugs, as may be necessary from the nature of the form of the board.

The caller and called are now in telephonic communication, and it remains for the first to attract the attention of the second, by ringing his bell, in order to hold the conversation.

Lastly, when done, both or one rings the bell; the tablets, which had been replaced by the switch clerk at the commencement of the conversation, again fall, and the plugs of each subscriber are put back to their normal place. This operation will be best performed, and with greatest efficiency, in a busy switch room by two clerks, one at the telephone, one at the board. That at the board will put up the indicator or tablets covering the numbers of the subscribers concerned, during the conversation, so that he will understand it is over, by their final fall, when one or other of the subscribers "ring off." If the board clerk looks at his board, he at once knows who are in connection, by the position of the plugs. If the caller cannot attract the attention of the called, the clerk will be aware of it, by seeing the tablets fall as fast as he puts them up.

This form of working possesses the advantage of simplicity, besides, first, of throwing on subscribers the responsibility of "calling up" and gaining the attention of the correspondent with whom they wish to speak; second, demanding the neceessity of the smallest amount of talking in the switch room, a matter of vital moment when there is much work. In several switch rooms in Europe, the method of procedure is somewhat different to that just described. The switch clerk, instead of merely saying to the "caller" the word "through," and leaving the rest to him, puts the switch room telephone into communication with the "called," whom he "rings up," and whose attention he first gains, and to whom he tells the name or number of the "caller," thus, as it were, introducing them to one another, and only then are they connected.

The superiority of the former way of working is self-evident. A disadvantage of ever adopting the latter, is that it is very difficult to get subscribers to agree to reverting to the former systems, chiefly from the force of habit. It may be argued that before the public was educated to the use of the telephone exchange, it was desirable to make it as popular as possible, and that was attained, by throwing on the switch-clerk the responsibility of bringing subscribers into communication. But it was radically wrong to follow a system, the burthen of which becomes too heavy as soon as an exchange is joined by 200 or more subscribers.

There are many sources of trouble, besides those due to electrical faults, in the working of telephone exchanges. One of these is known in America as "cuts off," due to a forgetfulness on the part of subscribers, by which they fail to "ring" when done with a conversation. One absolute remedy of this evil of failure to "ring out" is for the switch-clerk to "listen off" the conversation and connection, at the risk of hearing something that he is no more desirous of knowing, than the subscribers are anxious he should overhear Practice shows that not more than 80 per cent. of the subscribers can, at first, be induced to comply with this rule, but improvement soon comes. There are means of having it done automatically, one, a device of Mr. Johnson's, assistant to Mr. Edison. In it, the act of hanging up the hand or receiving telephone depresses a lever, not suddenly, which might not succeed, but slowly; and thus, during a interval of several seconds, a current is sent to him.

The same gentleman has described to me a further improvement, by which there is a distinction between the call of the subscriber for his correspondent and for the exchange. This is done in the following way. The battery current can be sent continuously or intermittently to him by the "caller," according as a little winch handle is turned by him to the right or left. The bells at the out-stations are chatterers, which act under the influence of a continuous current, but not of an intermittent. The annunciator at the exchange acts under the influence of an intermittent current, and merely vibrates slightly when a continuous one is passing. As long as the annunciator vibrates only, the switch-clerk takes no notice; but when the subscriber wishes to call the exchange, he turns the handle the opposite way, and the annunciator falls.

Often, subscriber A trusts to B to "ring out," or B supposes A will do it. The result is, neither rings, and the switch-clerk at the exchange is justified in supposing that A and B's conversation is going on. Now comes a call from subscriber C, who wishes to speak to A, and does not like to wait. The clerk looks at the board, and gives him "wait" or "engaged." Possibly C won't wait, goes out disgusted, and happens to call on A, tells him what happened. A replies that he has not used his telephone for some time, both are put out, and the telephone gets the blame.

Sometimes there is uncertainty at the switch-room, as to whether two subscribers are still in communication or not. One of them has possibly laid down his receiver, and is hunting for papers. This may last for half-an-hour. Meantime the switch-clerk, considering that an unusual time has elapsed, and finding nothing going on, has put all straight, and the correspondents are not a little surprised to find themselves disconnected, and have again to "ring up" the exchange. These little accidents and miscarriages are very characteristic of the individuals concerned. The chances of being misunderstood are many, especially when little attention is paid to the prime requisite of speaking *slowly* and distinctly, and the blunders occasionally made are extremely amusing. But education in the art of properly using the telephone is rapidly doing away with many of the mistakes commonly made at first. With more knowledge and more patience on the part of subscribers, there will be no further possibility of questioning the wonderful usefulness of this industry.

The next point in the construction of a switch-room, which requires a little explanation, has to do with the connection of subscribers who are attached to different boards. In the models shown, by the kind permission of Mr. Johnson, of Mr. Edison's, one switch-board provides for the attachment of twenty-four subscribers. To begin with, it is very easy to see how the numbers belonging to the same board—say 1 to 24—can be connected, and experience has shown the advantage of attaching to the same board persons who most frequently have occasion to communicate. When, however, as in the central station of the Paris telephone system, in the Avenue de l'Opera, there are 24 such boards in one switch-room, the connection between any two subscribers is not so easily made.

When the boards are not more than about 6 feet apart, connection can be made by means of two plugs with a covered wire connecting them metallically; over 6 feet such a connection becomes inconvenient. If the distance between any two boards is greater, the connection is made by means of commutator bars, running horizontally above or below the row of switch boards. The bar serves the same purpose as the covered metallic conductor does between the plugs. As the space for these bars are limited, their number is also limited, and it may occasionally happen that the number of bars between any two boards may be insufficient for the wants of the moment, when long connecting cords would have to be ready to meet the emergency. The use of cords alone, without commutator bars, has been extensively adopted. In such case, one large board is constructed for the attachment of 200 to 250 subscribers, but when 100 of them are using the exchange at the same moment, 50 cords are hanging on the front of the board, and great risk from entanglement is incurred.

The money value of the facilities afforded by the telephone exchange system to those who use it, it is hard to estimate, but we can place the probable cost of establishing it before you, and you can form an opinion if the outlay is repaid. For business purposes, Mr. Edwin Chadwick estimated, in 1868, the average money value to the public of every forwarded telegram at ten shillings. This was but estimate, but it showed that experienced men had thought out the question, and that the facilities of quick communication were highly estimated. The assistance given by a well-worked telephone exchange has caused the wonderful increase of its use in the United States. It is not easy to estimate the actual money value of the service to any individual, to do so the absolutely necessary use must be kept separate from the dispensable. It is quite possible that the regular use of a telephone exchange might save hundreds daily to a house of business. The power of oral communication between an office in a busy centre, and factories in a suburb, allows of a large saving in rents. Even the power of ordering goods from a tradesman save time and messengers. If the saving effected each time the telephone is resorted to amounted to one shilling, the annual gain would be considerable. The saving in mental wear and tear cannot be estimated, but there is no doubt that a high value will, in these days, be attached to the power of dealing at once with matters in hand.

The tariff of subscription in America is from £6 to £9 10s. a year on small social ex-exchanges; £10 to £21 on larger business and commercial ones. The highest comes to a little over 1s. 2d. a day. The tariff announced by the Postmaster-General, in 1881, which it was proposed to charge to members for connecting Parliament with clubs and private houses, was, half-a-mile from the House, £15; one mile, £19; and £4 for every additional mile; but I do not know if this was to include the use of the instruments and the service of an exchange switch. The rates charged in Paris are over £20 a year for each subscription, the exchange being open always; in Germany about £20.

When one comes to examine the first cost of establishing a system, and the annual outlay for maintenance, it is clear that the charges in Europe are very high, especially when it is considered that the cost of all telegraph apparatus and line material in the United States is 50 per cent. higher than in the United Kingdom. An exchange system for 50 subscribers, to begin with, in an area of about a mile diameter, requires an outlay of £20 for each station, and £200 for the switch room, tools, plant, and accessories; total, £1,200, the interest on which, at seven per cent., is £84 per annum. The annual maintenance and renewals will cost £4 each station, with its line, or £200 per annum, including the switch; the switch service will cost about £70; total annual cost, £354, or £7 per annum. When the numbers are increased to 100, the nett cost would be about £5 10s. a year.

Suppose that there was another similar exchange at a place three miles away, centre to centre, and 25 of the subscribers to the first wished to be able to communicate *through*, a trunk-line of three wires would be wanted, and additional apparatus and service would be necessary in the switch-rooms. This could easily be afforded at a nett cost of £3 a year additional to each of the 25, still charging seven per cent. on the outlay. In each case only a nominal rent for way leaves is calculated on, for reasons to be given hereafter.

These calculations, which make ample provision for the working and maintenance under ordinary conditions, show the enormous profits that might be derived from the present tariffs in Europe, supposing the management was good.

At any rate, my figures go to prove that, carried out at cost price by the association of the subscribers themselves, the telephone exchange is within the reach of the public, at a price which will be returned many times a year by its value in economy of time and labour. Unfortunately for the general public, whose advocate I am, the use of the telephone is restricted by circumstances arising out of the state of our laws. The benefit of the community is doubtless consulted, when patent laws promote inventive research, and secure the inventor the prospect of reward. Further benefit to the public is the result when patent laws secure a fair profit to all public organisations, which apply and administer inventions that require hard work and capital to place them at the service of the community.

But when these laws result in a restricted use of that which should be as free as air, for the immense benefit of a limited few to whom no public gratitude is due, then a state of the law obviously exists which is socially extravagant. Once the patent laws have secured the inventor and those who assist him to apply his invention, their fullest reward, they have done their duty. The natural increment in the value of an invention is the property of industry.

At the present moment there is a strong desire to confine the use of the telephone to the clients of a few public companies, and of one great public department. I am happy in believing that the means of communicating articulate speech at a distance will soon be as accessible to all as the means of aiding the vision with a telescope or a microscope. Meantime, it seems fitting that this Society should spread information on the subject, and tell the British public what they lose, for want of freedom to use the means of communicating articulate speech to a distonce.

The establishment of telephone exchanges is an industry; first as regards the manufacture of the instruments and the construction of the lines; and second, the working and maintenance of the systems. It is capable of universal application, and likely to be universally employed for all the transactions of life, if it becomes cheaper. At present it is hardly understood or known, the cost constitutes it a luxury, and the prejudice against overhead wires is a great stumbling block.

The Post Office Telegraph Depatment and the Telephone Companies stand chiefly in the way of its cheapening. The Post-office, in 1870, acquired a private telegraph business; having been obliged by Act of Parliament to purchase it on behalf of the nation, it has done no more than its duty in having continued and extended that business; and so judiciously has it been done, that a nett revenue not far short of £100,000 a year is earned by the State.

This industry, monopolised for ten years by the Post-office, was greatly affected by the introduction of the telephone, an instrument eminently applicable to a private wire business. And no doubt those responsible for the telegraph revenue felt uncomfortable. This feeling must have been seriously increased when the telephone exchange industry was introduced from the United States.

The Post-office, at the law process which followed in 1880, suggested priority of use of a telegraph exchange by itself, namely, at Newcastle, but wisely abandoned any claim which would seem to prevent anyone from imitating them.

The result of the judgment on that occasion interpreted the Postmaster-General's rights very widely. The general grounds of his plea were, his objection to anything which would interfere with the legitimate telegraph business or the Post-office, as authorised by Act of Parliament; but where the shoe really pinched, I think, was, the threatened decline which must ensue in the private wire business conducted by the Department.

Without the view of the loss of £100,000 a-year, I do not believe the Post-office would have gone to law on the subject, as no one is better aware than the Post-office telegraph authorities that the extension of the private wire and exchange industry (inevitable since the invention of the telephone), under proper legislative control, must very soon repay any such loss to the Department tenfold.

Unfortunately, or not, for the public, every point which should have told in favour of the defence, both legal and technical, seems to have been overlooked, and the general good policy of enforcing no Government rights which interfere with private industry was hardly referred to.

The advantages to the public of the Post-office entering the field of commerce, as distinguished from the national character of their telegraph business, are confined to one head, and a very important one, namely, that, with their system of telegraph lines and organised staff covering the country, they can very efficiently construct and maintain telegraphs for private purposes.

I fully sympathise with all the Postal Telegraph officials in any dislike they may have to seeing poles and wires, other than their own, growing up all over the kingdom, independent of their control. But I feel that we are only acting consistently with the true liberality of commerce, professed by the legislature of our country, in strongly protesting against the conduct or monopoly of the industry I have been describing by any Department of the State.

There is, however, a great work for the Post-office to undertake in connection with the spread of this industry, which is not only part of its duty to the public, but one which will eventually add largely to the business of its legitimate occupation. This work is, first, to free the use of the telephone in its fundamental forms from all alleged patent rights, the cost of which, if it costs even more than legal expenses, which remains to be seen, can be amply covered, and a revenue justly gained, by charging a small public license on the use of all apparatus for communicating articulate sounds. Second, to introduce a sound Bill, which will regulate the construction and laying down of lines of wire for telephonic purposes, over and through public and private lands, and for the maintenance of the same, by which local associations, under the Joint Stock Companies' Act, will have facilities which will enable them, under control by the Post-office, to establish exchange systems in every town, village, and neighbourhood throughout the United Kingdom. I allude to exchange, and not separately to private lines, because, as the establishment of exchanges extends, the use of exclusive private lines will decrease. It must not be forgotten that a subscriber to an exchange, practically, has a number of private lines in use equal to the number of the other subscribers.

If what I propose was followed, and legislation on the subject was obtained, the present rivalry in certain localities between the Post-office and the Telephone Companies, and between the companies themselves, would disappear. Dundee, not long ago, was the scene of such absurdity, when the pages of the local papers were filled with notices, threats, and defiances, from the contending sides. By all means let us have the advantage of competition, if necessary, but such rivalry as I speak of is not in favour of the extension of the industry; on the contrary, seeds are sown of difficulty and opposition, which tend to its annihilation, through objectionable work and extravagant demands for way leave, troubles which need never arise, if the simplicity of the application, working, and maintenance of this industry were allowed to become known.

We should in the future see the Post-office confined to its great national duties, the universal transmission and delivery of telegrams. A branch of the department could be established to exercise necessary Government control (for instance, like the control of the Board of Trade over the operations of Tramway Companies) over the telephone industry, and to see to the collection of telephone licenses. The erection and maintenance of wires on Post-office telegraph lines, on behalf of Exchange Associations, would still remain as a large source of revenue.

It may be argued that we are in the power of the Post-office and of the Telephone Companies. I will deal with the former. Its procedure in the past would seem to justify the suggestion of difficulty. But let us review the position of the postal telegraphs. In twelve years, by admirable work, the outcome of able men, more than able measures, the Department has gained a deservedly strong position without special powers; but, by wise conciliation and good management in spite of heavy opposition, its lines traverse half the roads in the kingdom. A great body of diligent and accurate public servants has been organised, into which has been infused the *esprit* and traditions of an historical Department of the State. The accuracy and speed with which the business of the vast national telegraph machine is conducted is unrivalled in any country. All this represents a great power, backed up with sound financial proofs and honest good work. But who would more readily admit than the Postmaster-General himself, that the whole system exists but by public opinion. We all know that, although the process is slow, strong valid reasons, thoroughly sifted, ably supported and soundly argued, always results in affecting public opinion, and legislation must follow, and when we look at all the great benefit which the Post-office has from time to time conferred on the country, we must feel convinced that the Postmaster-General, for the time being, will be always found in the van of any measure which conduces to the public good.

The cure of the difficulties offered by the owners of patents lies very much in the hands of the public itself. It is well known to them, but not enough by the public, that a little combination would soon bring them to an end. Wires, without which telephony cannot be used at present, cannot be put up or laid down without the leave of public bodies or private individuals. Combination against such works is perfectly legitimate until the companies reduce their prices, or give rational facilities for local associations to use their inventions. The companies cannot do without profits—the public can wait for its telephones; I ask, which will yield first? In the face of such combinations—founded, not against wires on their own account—which are not tenable—but against prohibitive tariffs, what monopoly can exist?

Philadelphia has taken the lead in such a line of action, and has lately granted way leaves for 2,000 miles of new wire on poles, but on conditions of the adoption of a tariff which is very moderate indeed in comparison with those as yet offered in Europe, the lowest rate for a private house being £8 a year.

But there is other assistance within call to the defensive combination I have suggested. Professor Dolbear, the advocate of cheap telephony, is ready with his condenser; and many other inventors have placed us beyond the reach of injunctions. To Professor Hughes, we believe, is due the honour of placing the microphone within the public domain; and therefore we may dismiss all fears, and go boldly forward in our advocacy of the use of telephony being placed within the reach of the million, by which the price which the British public is always ready to pay for good value will be repaid many fold in the saving to the community of wear and tear, bodily and mental.

It is entirely to the encouragement of a good end that the Society of Arts has this evening placed its arena at the disposal of the audience, for the consideration of what I have the honour to lay before you. I am anxious to clear the atmosphere of the public mind of many misapprehensions which I believe still exist; and I trust that the seeds may be sewn to-night of a growing agitation, which will end in our having the telephone industry as much used in the vast field of application to social life, as it is now growing into appreciation in the much more limited one of business life.

Last, but not least, it requires not a very long glance at probabilities to realise the great field for female employment which this industry opens up. When it is acknowledged that telephone exchanges must be always open, the objection to night-work for females is met by the fact that the switch-clerks can always sleep on the premises, if, as no doubt will be the case, the switch-room is rented in the same dwelling that is inhabited by the family whose female members supply the clerks. Some thought is required to realise the great social changes which the wide use by the public, in its daily life, of this industry will surely and gradually produce. Not only will daily habits alter, but work will be done with less friction; there will be more leisure for the industrious, and more control over the idle. Less time will be lost, or wasted; much money will be gathered while the sun shines.

Finally, there is a great social aspect of the use of this industry, which will materially affect the body politic, namely, the question of public order, and the preservation of the peace. To this meeting, I commend the consideration, whether it is the case, that power of communication between a number of householders means rapid combination against disorder, rapine, or burglary, which no police regulations could ever supply, and that comparative security and succour will be afforded in thousands of cases in which now it is dependent on accident.

DISCUSSION.

Mr. **Graves** said he felt, as an officer of the Post-office, especially disqualified from following Colonel Webber into many of the points suggested by his paper. The Post-office was, to a certain extent, carrying on a telephone exchange business; it was carried on to a much larger extent by private companies, their licensees, and he could not therefore go into the mode in which either the one or the other should conduct its business. There were one or two points, however, on which he might offer a remark. Colonel Webber seemed to think that the objection to overhead wires was a bugbear, and that it was very desirable that the public should be educated to believe in the advantage of great masses of wires crossing the thoroughfares. Now the Post-office had many overhead wires, and must continue them if it carried on its operations, because there were many localities in which the business would not pay for an underground system. But wherever wires were massed in large numbers, two things followed:—First, there was great difficulty in finding room for them on the supports on the tops of houses; and, secondly, the weight became a source of danger, consequently, wherever they accumulated beyond a certain number, the Department found it necessary to place them in pipes underground. He did not see how any Postmaster-General could logically defend what must, to some extent, be a source public danger. Whenever the wires exceeded a certain number, there was a double difficulty; oxidation was going on which was intensified in the neighbourhood of smoke, in a way impossible for human eyes to detect, and you could never be sure that some wire was not giving way at some point which might be a source of danger; and again, there was danger from the contractile effects of frost. Therefore, while they did not say that all wires should go underground, it was only right to say, that wherever they became heavy, they should do so. He scarcely knew whether he rightly apprehended Colonel Webber's views with regard to telephone patents, but if he did, the idea was, that the Post-office was to buy up every patent which was brought forward. That might be an excellent thing for patentees, for telephony was yet in its infancy, but he did not think it a sound commercial policy. He agreed it was very desirable to carry a Bill conferring powers for the erection of the lines on public and private property, and he wished they had such powers; but the English law took peculiar views with regard to interference with private rights, and whenever compulsory powers were conferred, you generally had to pay pretty large compensation for their exercise. He took it that the Post-office were expected first to make a sure market for all patents, by buying them, and secondly, to remove all difficulties from the way of companies, by finding them a roadway which it must pay for at any price required, and he did not think that was commercial policy either.

Mr. BATTEN said he was a director of the company which claimed to hold the master patent, and to have these wonderful monopolies; but he also claimed that his company had given a telephonic system cheaper than any in the world, for they were carrying messages at an average of 1d. each for all their subscribers, and many of them paid an average of only ¼d. By alliance with the Post-office they had been able to supply at present but a limited number of people—a mere scratching the very surface of the population; but they were giving the people of London 26,000 messages in one day, only a thousand short of what the Post-office itself did; and that had been attained in the course of two years, whilst the Post-office had grown to its 27,000 in many years. Yet they were told they were monopolists. Now, he must say, that this was the only thing in which monopoly was justified; monopoly in every other trade or business was a curse; but, and he challenged any one to deny it—monopoly in telephony was a blessing. He would ask his hearers to think over this when they went home, and then let anyone write to him, and show him that the Post-office was wrong in saying that there must be a monopoly. If there were not, it would be like teaching one language in a Board school in Westminster, and another at the East-end. Every person connected with the telephone exchange wanted to speak to every other person who had a telephone, and he could not do that if there were more than one system. The Bell Company and the Edison Company tried it, and what was the result? Every banker of standing who had clients in each company, had to subscribe to both. He was sorry, as a Liberal, to say so, and he could fancy that the Postmaster-General in a Liberal Government would hesitate about it, but you must have this monopoly of telephone communication if the system were to become general, and to be the poor man's telegraph. The telephone was being used to-day, in the East-end of London, 46 times a day, by every subscriber, for 1s. 3d. a day. He could send fifty messages if he liked; and could you have anything cheaper than that? He challenged his friends of the Post-office to put up a telephone in every chemist's shop in London, and let the public send penny messages. He believed in the third-class; the third-class passengers paid the dividends of railway companies; and he believed they could, in conjunction with the Post-office, put up a thousand, or two thousand telephones in shops in London, in which every person could go in and speak, on payment of a penny, and that it would pay well. Any person within five miles from there might give an order for a telephone to be put up in his house, at a cost of £20 a-year, which would be an average of 1s. 3d. a-day, and it would pay a person to do so, and take in messages at 1d. a piece. The Government might undertake this business, and find it perfectly remunerative. It was not only the mere fact of being able to send so large a number of messages for such a small sum that made the telephone valuable, but there was the inestimable advantage that you got an immediate reply, and you knew, by the voice of the person, whom you were speaking to, which you did not in the case of a telegram. Colonel Webber quoted the telephones which were in use at a lower rate in other places, and it was easy, in a country district, to put up a telephonic exchange system, which would cost only £7, £8, £9, or £10 per subscriber; in America they had telephones at £8 a-piece, but they were hung like cherries on a stalk; only one person was speaking along the wire at once, and the telephone having been taken down, cut off all the rest. They had tried that, but the English people would not have it; they would have a telephone to themselves. As there were several gentlemen connected with the Post-office present, he wanted to appeal to them. It was said that this large number of telephonic messages interfered with the telegraphic receipts; but he stated twelve months ago that he believed it would not have the smallest effect, and he challenged them to say whether it had. The use of this system created such a desire for quick communication, that a person who had a telephone in his house, used the telegraph ten times more than he did before. He, himself, constantly used the telegraph when he used to send letters, and he found, from inquiries amongst the subscribers, that they all of them did the same. He, therefore, appealed to the Post-office to extend their system, and make it the fingers of the telegraphic hand.

Professor SYLVANUS THOMPSON said he had, unfortunately, not been in time to hear the paper, but if he correctly caught the gist of the last speaker's remarks, it was that they should not have anything new in the way of a telephone. Now, he was of opinion that it was better to have something new—that there should be a healthy rivalry, which would tend to improvement. As to Professor Dolbear's telephone, which had lately come to England, which worked by statical effects, he could only say that it surpassed any which had yet been put into his hands, in one respect—that for long line work. Where there was what was commonly called induction, but which he believed to be a kind of gentle leakage from other lines, it was infinitely superior to any he had seen.

Mr. PATEY said he would endeavour, as requested by the Chairman, to say a few words on behalf of the Post-office, and show how far it was willing to meet the public wants. He agreed with Mr. Batten, that it should endeavour to do so as far as possible, and it had under consideration at the present moment the very question which Mr. Batten had raised, viz., whether it was more beneficial to have one large company like the United Telephone Company, or a number of companies doing business throughout the kingdom, and more especially in London. Mr. Batten had given his reasons for thinking there should be a monopoly. Now the question of monopoly was fought out some years ago when the Post-office took over the telegraphs from the old companies, and it was then thought that a monopoly was good, but that it was good only in the hands of the State. A private company, although it might be pressed, was not necessarily obliged to yield, but the State represented by the Postmaster-General, was bound to give the greatest possible facilities to the public. There was no doubt, therefore, that any monopoly which was given should be given to the Post-office, and not to a private company. Still the question had gone a little further than that, because the Postmaster-General was willing that the company which had started telephones in this country should have a license to carry on its operations; but, in giving such license, he took care to guard himself and the public generally, by inserting a clause that he himself should have the power to come in and give the public what the company could not give, or give the same when desired. In some towns the Post-office had established exchanges where the company was at work, not for the purpose of competing with the company, but simply as guardian of the public rights, to give facilities which the company did not afford, and in other towns exchanges had been set up where there would otherwise have been none. They might rest assured that the only desire of the Post-office was to give the public the best system possible; and it was simply a question whether one system or more was the better. They knew that in London there were originally two companies which had amalgamated for the reasons Mr. Batten had given. Still, some new invention might arise which might not be worked by the present company, and the public ought to have an opportunity of deciding which they liked best. No doubt there would be a difficulty if there were two exchanges. If the same system were used there would be no benefit, and if difficult instruments were used, a person on one system could not speak with one on the other; and he must subscribe to both. On the other hand, if an inventor brought forward a new instrument which might be a slight improvement, he would find it very difficult to get it taken up by a company, which had say, 20,000 instruments already in use, and which answered the public requirements fairly well. In the case of the Post-office, more pressure could be brought to bear, and if any new invention was required it must be adopted. The question of license was under consideration, and the Postmaster-General would certainly endeavour to do what was best for the public interest. With regard to the question of patents, there was the difficulty he had already alluded to; it would be impossible for the Post-office to buy up all patents. That difficulty had been found with regard to telegraphic instruments. They tried to adopt those which were best for public service, and if any new one were brought forward, they were bound to try it. One of the old companies used principally the Bell instrument, and another the Morse, in different forms. When the Post-office took the companies over it was found better to have a uniformity of system, and it abandoned the Bell system, except on a few circuits. The Wheatstone apparatus had been in use a long time; especially on long lines, then the duplex came out, which was also adopted; then the quadruplex was brought to them, and under the system proposed by Colonel Webber, they would have had to pay for the quadruplex the same as they had paid for the other two. But they found, on going into the question, that there would hardly be room enough for the three; and he took it, that commercially, no person would pay for the third, having the other two, which between them did nearly all that the third could do. They did use the quadruplex to some extent, paying a sum which they deemed sufficient, and which had been accepted by the person who brought it forward. With regard to the question of a Bill, Mr. Greaves had pointed out the difficulties any department would have in compensating private owners. The Post-office had not experienced any great difficulty in getting their lines through, though of late, larger prices had to be paid—partly in consequence of the competition of other companies. They found that where a large number of wires had to be carried along a street or road, it was advisable to take them underground, and that had been their policy for some time; not a policy of putting every line underground, which in many cases would be impossible. It should be looked at rather in this way, that underground lines were put down as an addition, and not as a substitute for overhead lines. At present, there were about 130,000 miles of line in the United Kingdom, and it could not be expected that the whole of them could be put underground; and in the country, in back streets and for private wires the expense would be too great. With regard to the cheap telephony, and the farthing messages, to which Mr. Batten had alluded, he was glad to hear that his company were willing to undertake that. The Post-office had lately made a proposal that messages should be taken in by the telephone companies at various places, and he had seen the company on the subject that very day, but he certainly had not offered them a farthing, or even a penny, a message.

Mr. BATTEN said his statement was that some of their subscribers used the telephone to such an extent that the average cost per message did not exceed ¼d. He did not propose they should be taken at that rate.

Mr. PATEY, continuing, said the Post-office wished to make them as cheap as possible, and were willing to give every possible facility, but he thought there was a little misapprehension in supposing that everyone could go into an office, and for the payment of a ½d. or 1d., speak to any one else and get an immediate answer. As Colonel Webber had pointed out, trunk wires were needed to connect the different exchanges, and if anyone could go into a shop and speak to any one else, a very large number of these trunk wires would be required in London and other large towns. At the present time, although the number was limited, some time always elapsed before you could speak to another subscriber, and it was hardly accurate to say you could get an immediate answer, unless you had an enormous number of wires. With regard to the influence on the Post-office receipts, it must not be supposed that no effect would be produced. At the present time, telephoning in London had only been extended a short distance—especially to Westminster and the City—and if it were extended over a larger area, there was no doubt the income of the Post-office would very much diminish, and then the desideratum of a lower rate than 1s. would be postponed. Statistics showed that the telegraphic business round London was the greatest, from the furthest distances to the centre, and as the telephone was extended, it would more and more affect the telegraphs. The telegraphic receipts were, to a great extent, derived from short distance telegrams; and if they were diminished, the profit would be less, and perhaps would be converted into a loss.

Lord OTHO FITZGERALD said he had long taken an interest in all telegraphic matters; the first overhead wire in London was on his house. He was the first member of the House of Commons who had a private wire from his house to Westminster, and he had recently had a telephone fitted up. He wished to ask whether it was proposed to introduce telephonic communication between large towns like Manchester, Liverpool, and Birmingham, and whether it was really going to be a case of direct rivalry between the telephone and the telegraph. The telephone exchange was already established in most large towns, and all they really wanted now was communication with each other. It would be a great advantage, and would, he thought, assist the receipts in both casses, if telephone wires were allowed to run into the telegraph offices, because, then, as had been stated, those who used the telephone would be still more desirous of using the telegraphic system.

Mr. PATEY replied that the Post-office had already given a license to the different telephone companies to join up the exchanges in different towns. The Post-office had joined up Manchester and Liverpool, and various other towns, and for some time subscribers in Manchester and Liverpool had spoken to one another as if they were in the same town. With regard to the second question, the Post-office had already made arrangements for wires to be taken to various Post-offices on payment of a fee for each subscriber, or had allowed the various telephone exchanges to accept messages from their subscribers in the suburbs, write them out, and hand them in, the same as if they were handed in by the subscribers themselves. They were also willing to extend the system to as many other towns as might desire it.

The CHAIRMAN said he did not wish to take much part in this discussion, nor was it for him to reconcile the difference between the telephone companies and the Post-office. It was a great question in economics, whether a monopoly was ever an advantage, but of course they knew there were some cases in which a monopoly established in the public interest was the only way in which a certain kind of business could be done. The best example of that, perhaps, was the Post-office itself. It would never do, as was the case some 200 years ago, to allow private persons carrying letters to compete with the Post-office; this work could be done far cheaper and better by a great public institutiion than in any other way. That might be also true of the telephone; but he did not think the Post-office, in adopting or taking part in the telephone business, ought to have an eye to saving itself loss in the telegraphic business. If it were true that the telephone was a great advantage in the transaction of business by the public, they must be content to make a loss on the telegraphs, and the public would support them in their contentment. It would never do for the Post-office to say, we have paid a high price for the telegraphs, and, therefore, we must try and save the public from loss through some new invention cutting into our profits as telegraphists. That was the sort of argument which might have been used, if coaching had been a State department to prevent the introduction of railways. If you were to carry on any business where profit was the aim, you must run the risk of future improvements cutting into these profits, and if it was a public department it must cheerfully accept the loss. As far as one could see, it was an accident that the Post-office had anything to do with this telephone monopoly. Mr. Walter was the only person besides himself who, at the time the Telegraph Bill was going through the House of Commons, objected to a general clause put in by the Department, giving them the command of all future inventions with reference to communication between man and man. He remembered objecting at the time that possibly there might be an invention which would be a substitute for telegraphs, and this was practically giving the Post-office a control over future scientific advancement, which was not for the interest of the public in the long run. However, he was *vox clamans in deserto* on that occasion; the public Department was too strong for any independent member to stand up against in the public interest, and on that very clause the Post-office founded their contention that they had a right to this monopoly of a mode of communication which, at the time it was passed, was never dreamed of. Such being the law, the public had now to get the greatest possible benefit out of the invention, whether from the Post-office or the telephone companies. They might hope that the Postmaster-General would so use the powers which the State had given him, as to afford every facility for the spread of this wonderful method of communication; as yet it was only in its infancy, and in a few years, he was convinced, it would be the ready method by which the greater part of the business in the metropolis and other large cities would be conducted. He was glad to hear from Colonel Webber that he conceived that by proper precautions overhead wires might be made matters of ornament and advantage to a great city. He confessed that when he walked about sometimes in the crowded streets in the City, and looked at the spider's webs which spread so thickly overhead, it seemed as if the light of day would at some time be shut out entirely. If he had any plan by which an æsthetic appearance could be given to these wires, he would certainly be a benefactor to London, but, at any rate, they were much indebted to him for the very clear and able paper he had read.

Lieut.-Colonel **Webber**, in reply, said Mr. Graves had not quite understood the tenor of the paragraph in which he had referred to the great work the Post-office had before it of freeing this great means of communication, which he described as one which should be as free as the air we breath. Mr. Graves had condemned his proposal as being exceedingly uncommercial; but if gentlemen would read the paper carefully they would see that he had not made the proposal that the Post-office should buy up all the patents, as was supposed. Everything Mr. Batten had said was of a most interesting character; it showed the progress telephony had made in London and in the great cities; but he would remind the meeting that he advocated the application of this system of exchanges all over the country, even to villages. The work it might do, and would do, some day, in the assistance it would give to the daily affairs of life, would be enormous. Therefore, in comparing what he proposed with what Mr. Batten had described, they were dealing with two different things. He was thinking of telephony more in its general application. In a paper of three-quarters of an-hour's length, it was impossibie to touch on all the difficulties and possibilities which would come into operation in a large city like London. He endorsed all that had been said by Mr. Batten of the advantages of telephonic communication, and went much further. That part of the work to which Lord Otho Fitzgerald referred, the connection of the exchanges in great towns must necessarily be an expensive operation, because of the greater number of services required, and, therefore, its use would probably, be confined to persons who had commercial transactions of considerable value. He had not touched on that, amongst the many subjects connected with telephony which he had in his mind. Those were exceptional cases, and he was quite sure that if that part of work were left in the hands of the Post-office, nobody could do it better. The question of overhead wires and their unsightliness was one which would require a whole evening to discuss, but he never meant, as Mr. Graves seemed to think, that a line of thirty or forty wires should be placed overhead. He was referring to the establishment of telephones all over the country, not to densely populated places. In London, you could easily find occupation for one telephonic exchange in one block of buildings. He had no doubt there were difficulties in connection with the subject, which would puzzle many a head, and those foreshadowed that evening were very small indeed, compared with what might occur when the system began to be adopted extensively. He hoped this paper would be recognised as merely the opening of a discussion amongst the public, as the result of which they would eventually see, by some means or other, systems of telephonic exchanges established broadcast over the land.

Mr. **Graves** asked Colonel Webber in what respect he had misunderstood him. It appeared to him that the words he referred to were only capable of one meaning, viz., that all inventions for the improvement of telephonic communication must be purchased by the Post-office.

Lieut.-Colonel **Webber** said it had not that meaning. The phrase, "fundamental forms of telephone" was well known to those who understood the subject. One of those forms was Professor Hughes's, and they all knew what the other one or two were.

The **Chairman** then proposed a vote of thanks to Lieut.-Colonel Webber, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

THE KOLA OR GOUROU NUT.

These seeds, called Ombémé nuts, are the produce of *Sterculia acuminata*, belonging to the natural order *Sterculiaceæ*, and are known to us by the accounts of West African travellers, who state that when chewed or sucked, they possess the power of rendering the flavour of water, even if half putrid, agreeable, and they were believed to contain caffein. They have recently been made the subject of analysis by MM. Ed. Heckel and Fr. Schlagdenhauffen, who have found that they do actually contain more caffein than the best samples of coffee that could be procured, and that this base is altogether free and uncombined—not, therefore, as in the coffee berry, united with the organic base; secondly, that they contain a very appreciable quantity of theobromine, which assists the action of caffein, and possesses similar properties to that base; thirdly, which is an important fact, that they contain a considerable quantity of glycose, of which cacao presents no trace; fourthly, that the quantity of starch present is three times greater than that contained in theobroma, which explains its nutritive value; fifthly, that there is but little fat, in which respect it differs notably from cacao; and, lastly, that they contain a special form of tannin, which approximates caffeo-tannic acid in its composition, and a red colonring matter, very similar to that named by Payen cacao-red. The physiological examination of this substance has shown that its properties are essentially due to the caffein and theobromin it contains. The seeds, it appears, have long been in use in Soudan and Western Africa, for the relief or cure of diseases of the intestine and liver, and especially in cases of atony of the digestive tract, and also as a masticatory and tonic, like the areca-nuts, which are held in such high esteem by the natives of India. Medically, they may come to occupy a prominent place by the side of coca and other anti-metabolic remedies, to which they would probably prove superior in consequence of the tannin they contain.—*Lancet.*

Correspondence.

COAL PRODUCTION.

Is it strictly correct to work out the coal production at p. 573 as coal production per head? It is true it is not coal consumption, but the production has no necessary connection with the population of these islands. The coal production, as stated, is largely on foreign account, 19,000,000 tons; and then there is the coal consumed for item "exported."

Hyde Clarke.

32, St. George's-square, S.W.,
April 22nd, 1882.

THE CHANNEL TUNNEL.

The discussion upon the Tunnel having been closed abruptly, many withdrew; the time being absorbed in lengthy discourse.

As a constant *voyageur* to the Continent, I wish to make a few remarks. I believe that a tunnel may be made, and probably held, but yet I am for keeping inviolate — not our insular prejudices, but our insular position, intact; a position that bountiful Nature has bestowed upon us; an exceptional frontier, which has given us the command of the high seas, and made our island the *entrepôt*, Britain the bank, and our shores a refuge for the proscript, a frontier that, had it been created by the hand of man, would have been the first wonder of the world.

I believe that no one has argued that bridges, balloons, or marine tunnels, will aid in the education of sailors, or enhance our supremacy at sea. Doubtless it will greatly facilitate the transportation of foreign goods and supplies, detrimented by breaking bulk; it will do little for our coal trade, or our neighbours' commerce in wine, which is not only benefited by transit, but put at our doors cheaper than in Paris.

Now, we well know that France has voted large sums to the deepening of twelve harbours, opposite to our shores, a thing that ought to be a great boon to us, who do all the carrying traffic by sea; though, doubtless, if the Tunnel be made, French carriages and conductors will not be long before they reach Charing-cross, or even Carlisle.

It seems a great pity that the energy, pluck, and perseverance of Englishmen, and particularly of those connected with our southern railways, should not have been directed to the prosecution of direct lines between the capitals of England and France (as the crow flies), instead of taking as many miles out of our way up, as it were, to come down again; and it is really doubtful, if the Tunnel be made, if it will or can compete for speed with a service that might and ought long ago to have been organised at Dungeness, where there is deep water and every facility afforded by nature for the formation of a grand harbour of refuge. The place is protected from most sides, and needs but little to create a huge basin in which fleets could lie in safety, and large steamers depart at all tides. London might with ease be brought in one hour and thirty minutes in communication with Dungeness, where a portion of the train should be shipped, whilst the passengers (who are but packages with the advantage that they deliver themselves) would walk aboard. The Mid Kent line needs do but little to complete this route. The distance from London to

Paris might roughly be calculated thus, Treport being about half-way—one-fourth would be to our coast, one-fourth on the sea, down channel, and two-fourths in France, there being a direct line from Treport to Paris, the terminus of which is in the centre of the city, and not, as in our present mail route, away in a northern suburb where half-an-hour may be lost.

The French are an enlightened people with grand traditions, but as those traditions are of a bellicose nature, and as they own themselves *très guerrier*, to be forewarned is to be forearmed. We have only to stand upon the cliffs at Folkestone in fine sunny weather to see Boulogne, and there to behold a column erected by the first Napoleon, to commemorate the invasion of this country, an invasion that never took place, and for why, because the Channel Fleet was there, and the camp after that broke up, and La Manche and the Pas de Calais remain only French in name. Seven years ago, I ventured to assert in the *Times* that the journey might be done in eight hours, as it has been; I now believe that we might leave London at noon and dine comfortably at Paris at seven o'clock.

JOHN LEIGHTON.

General Notes.

SCHOOL BUILDINGS EXHIBITION.—An exhibition of plans and models for school buildings in Paris is now being organised by the French Minister of Public Instruction. Already 300 architects and contractors have notified their intention of exhibiting, and every province of France, including Corsica and Algeria, is to be represented. The exhibits are expected to be diversified, owing to the various needs arising from different altitudes and climates. It has been decided to hold the exhibition in the Passy Wing of the Trocadéro Gallery, and the plans, models, and drawings must be delivered there between May 1 and May 15.

THE PARKES MUSEUM.—A general meeting of the subscribers to the Parkes Museum of Hygiene was held on Tuesday, 18th inst., in the Museum, University Collge, Mr. Berkeley Hill (treasurer) in the chair, to consider the advisability of making application to the Board of Trade for a license to incorporate the Museum. The room at present used as a Museum is full, and intimation has been received from the Council of University College that this room will be required for other purposes at the end of the present session. Before making an appeal to the public for the necessary funds, it is thought essential that the Museum should be placed on a secure legal basis. Since the opening of the Museum, it has been visited by over 5,000 persons interested in sanitary progress, exclusive of those who attended the lectures, demonstrations, and general meetings.

SOAP AND CANDLE EXHIBITION AT BERLIN.—An Exhibition, the first of its kind, is announced for June and July next, in Berlin, of the raw materials and plant used in the manufacture of wax and tallow candles, and soap.

EXPORTS OF AGRICULTURAL PRODUCE FROM ITALY TO ENGLAND.—The export of fresh provisions from Italy to England, commenced about six years ago by Messrs. Civio and Co. of Turin, is rapidly increasing. The route taken is over the Brenna to Antwerp, when the goods are shipped on the Great Eastern Company's steamers for Harwich. The whole distance is accomplished in about five or six days, and it is anticipated that the service will be accelerated when the steamers run daily. The articles exported include eggs, butter, cheese, fowls, wine, green vegetables, &c. The export of eggs amounts to an average of 6,500 cases per month, that of butter to 3,000, and about 1,000 cases af miscellaneous goods. The total weight sent over ranges from 320 to 600 tons, according to the season. It is confidently anticipated that the opening of the St. Gothard railway for regular traffic this summer will largely develop these exports from Italy.

POSTAL UNION.—The Geneva correspondent of the *Times* gives the following postal statistics:—"A return has just been issued by the Bureau of the Universal Postal Union at Berne, from which it appears that in the year 1881 the countries constituting the Union received and despatched 3 milliards 866 million letters, 649 million ordinary post-cards, 1 million post-cards with answers prepaid, 1 milliard 983 million newspapers, 1 milliard 98 million packets of printed matter, 64 million samples, 98 millions of small parcels, and received and paid in post-office orders sums aggregating £320,180,000. At this rate 3 milliard 418 million letters are every year distributed in Europe, 1 milliard 246 millions in America, 75 millions in Asia, 36 millions in Australia, and 11 millions in Africa, equal to 3·5 letters for every inhabitant of the earth. The Federal Post-office also makes a good show for 1881, the number of letters distributed in that year being 49 millions, against 41 millions in 1880. But the most remarkable feature of the Swiss Post-office is the large business it does in money orders, and the immense quantity of packages, parcels, and boxes it forwards. In the year in question 12½ millions of packets, small parcels, and *papiers d'affaires* were received and distributed within the limits of the Confederation, and 11 millions sent to and received from foreign countries. The turn-over in orders, home and foreign, amounted to upwards of 240 million francs, and the Department distributed 6,806,901 boxes and other large packages—facts which, seeing that the population of Switzerland is under three millions, are as significant of the energy and activity of the people as of the efficiency of the Federal Post-office."

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

MAY 3.—"The Fire Risks incidental to Electric Lighting." By T. BOLAS, F.C.S. W. H. PREECE, F.R.S., Member of the Council, will preside.

MAY 10.—"The Fish Supply of London." By SPENCER WALPOLE, H.M. Inspector of Fisheries. W. H. GLADSTONE, M.P., will preside.

MAY 17.—"The Constant Supply and Waste of Water." By GEORGE F. DEACON. Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, will preside.

FOREIGN AND COLONIAL SECTION.

Thursday Evening, at Eight o'clock :—

MAY 25. — "Recent Passages of Zulu-Kafir History." By ROBERT JAMES MANN, M.D., F.R.C.S., F.R.G.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at Eight o'clock :—

MAY 11.—"The Recovery of Sulphur from Alkali Waste. Schaffner's process. A record of recent results." By ALEXANDER M. CHANCE, of Birmingham.

INDIAN SECTION.

Friday Evenings, at Eight o'clock :—

MAY 5.—"Experiences of an European Zemindar (landholder) in Behar." By JAMES MYLNE.

MAY 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 1...Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Professor Scott, "Recent Advances in the Science and Practice of Agriculture."

Royal Institution, Albemarle-street, W., 2 p.m. Annual Meeting.

British Architects, 9 Conduit-street, W., 8 p.m. Ananul Meeting.

Medical, 11, Chandos-street, W., 8½ p.m. Annual Meeting.

Victoria Institute, 7 Adelphi-terrace, W.C., 8 p.m. Prof. Reinsch, "Investigations as regards the Formation of Coal."

TUESDAY, MAY 2....Charity Organisation (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Conference of members of Charity Organisation Societies throughout the country, members and supporters of charitable institutions, and others. Mr. C. S. Loch, "Some Necessary Reforms in Charitable Work."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. B. Tylor, "The History of Customs and Beliefs." (Lecture III.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. L. F. Vernon-Harcourt's Paper, "Harbours and Estuaries on Sandy Coasts."

Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.

Biblical Archæology, 33, Bloomsbury-street, W.C., 8 p.m. 1. Rev. A. Löwy, "Notes on Glass, according to Ancient Jewish Records." 2. Mr. George Bertin, "The Rules of Life among the Ancient Akkadians."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. J. E. Harting, "The Desirability of Adopting a Standard of Nomenclature when describing the Colours of Natural Objects." 2. Dr. Hans Gadow, "The Structure of Feathers in relation to their Colour." 3. Mr. W. A. Forbes, "Note on an Abnormal Specimen of *Pithecia satanas*." 4. Prof. Flower, "The Cranium of a new Species of *Hyperoodon*, from the Australian Seas."

WEDNESDAY, MAY 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Thomas Bolas, "The Fire Risks Incidental to Electric Lighting."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 4 p.m. Annual Meeting.

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, MAY 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. S. Grieve, "Notice of Remains of the Great Auk found in Cronsay, Argyllshire." 2. Mr. Harry Bolus, "Cape Orchids." 3. Mr. B. D. Jackson, "Demorphic florets of *Catanche lutea*." 4. Mr. P. H. Gosse, "Butterfly Genitalia." 5. Baron de Villa Franca, "New Varieties of Sugar Cane."

Chemical, Burlington-house, W., 8 p.m. Prof. J. Dewar, "Recent Developments of the Theory of Dissociation."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Metals." (Lecture III.)

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. General Meeting.

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, MAY 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Indian Section.) Mr. James Mylne, "Experiences of an European Zemindar (Landholder) in Behar."

Royal United Service Institute, Whitehall-yard, 3 p.m. Captain Chandos Hoskyns, "A Short Narrative of the Afghan Campaigns of 1879-80-81, from an Engineer's Point of View."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. R. Grant, "The Proper Motions of the Stars."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Mr. E. L. Brandreth, "Some Notes on Grammar."

SATURDAY, MAY 6...Meeting of School Managers (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m.

Physical, Science Schools, South Kensington, S.W., 3 p.m. Mr. F. D. Brown, "The Mercurial Thermometer."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Pollard, "History of the Science of Politics." (Lecture III.)

Journal of the Society of Arts.

No. 1,537. Vol. XXX.

FRIDAY, MAY 5, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SOCIETY OF ARTS' PATENT BILL.

This Bill was read a second time on Friday last, the 28th ult. Sir John Lubbock, in moving the second reading, said that the Bill had been very carefully prepared by the Society of Arts, and on their behalf, and in their name, he asked the House to assent to the second reading. The Bill was of a comprehensive character, and dealt with the whole subject of patents. It was understood that the Government had prepared a Bill which he believed would be referred to a Select Committee, and if the House assented to the second reading, he would then defer further action in order to move that this Bill should also be referred to the same committee. The President of the Board of Trade had been so good as to intimate to him that the Government would assent to this course.

The Bill is set down for Committee on Monday, the 22nd inst.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 14th June. The cards of invitation will be issued shortly.

EXHIBITION OF MODERN ENGLISH POTTERY.

The arrangements for the Exhibition of Modern English Pottery, to be held at the House of the Society, are now completed. The following firms have, on the invitation of the Council, kindly consented to exhibit specimens of their work:—Messrs. T. C. Brown-Westhead, Moore and Co., Messrs. Henry Doulton and Co., Linthorpe Art Pottery Company, Messrs. Maw and Co., Messrs. Mintons, Messrs. Wedgwood, and the Worcester Royal Porcelain Works. The Exhibition will be opened on Monday, 22nd of May, at 10 a.m., and will probably be kept open every day from 10 to 4, until the end of June.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

A Catalogue of the Exhibition will be issued with the next number of the *Journal* published after the opening of the Exhibition.

The Council regret that owing to the limited space at their disposal, they are unable to avail themselves of various obliging offers of additional objects which have been made to them.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, assisted by W. A. Barrett, Mus. Bac. Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 10th July, 1882.

HONOURS.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

FIRST AND SECOND-CLASS.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named

by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, April 25th; Sir RUTHERFORD ALCOCK, K.C.B., in the chair.

The paper read was:—

REMARKS ON THE CHARACTER AND SOCIAL INDUSTRIES OF THE INHABITANTS OF CHINA AND JAPAN.

By LIEUT. THE HON. HENRY N. SHORE, R.N.

I have been requested to contribute a paper on "The Character and Social Industries of the Inhabitants of China and Japan." But I need scarcely observe that it will be impossible to do more than break ground on a subject of this nature, within the prescribed limits of time. Indeed, to treat it with any sort of completeness would require a kuowledge of these countries, as well as of the language, literature, manners, and customs of the people, to which I can make no pretension.

I trust, however, that I shall fulfil to some extent the special objects of this Society, if, by correcting certain wide-spread misconceptions I can help you to form a juster estimate of the inhabitants of these distant lands; and by thus removing some of the impediments to a friendly intercourse, assist to promote the peace and prosperity so essential to the development of arts, commerce, and manufactures.

In the first place, I shall ask your kind attention for the greater part of the evening to China. 1st. Because it is the oldest nation in the world, with a history extending back 4,000 years, and, what is still more remarkable, with a form of civilisation which, in all its essential features, presents the same aspect to a traveller at the present day as it did upwards of twenty centuries ago; 2nd. Because, from the geographical situation of the country, its extraordinary fertility, its vast undeveloped mineral and other resources, and the high intelligence, sobriety, and industry of its people, China seems destined to play a momentous part in the future history of the world, and for this reason has a greater claim on our interest than any other country in the East; and lastly, because most travellers, and nearly all recent writers, have shown a tendency to cry up the Japanese at the expense of their neighbours, until it has come to be taken for granted by many people, that the Chinese are not only greatly inferior, socially, morally, and intellectually, to the Japanese, but that they are an utterly hopeless and stupid people, destined to give place to a more intelligent and enterprising race.

Sir John Davis complained long ago "that the Chinese have, upon the whole, been underestimated on the score of their moral attributes, and that a character of silly levity and farce has been associated with one of the most sober, steady, considerate, and matter-of-fact people in the world, who in grave matters of business are often a match for the best of Europeans." And this complaint still holds good; indeed, so far as my own experience goes, I believe it is no exaggeration to say, that ninety-nine people out of every hundred seem to have formed their estimate of the nation from Bret Harte's inimitable ballad of the "Heathen Chinee," and look upon thse people as a cat-and-dog-eating, card-cheating, opium-smoking, absurd race, without any system of education, culture, or literature, or any of the conveniences and luxuries which go to make up what we call civilisation.

We should also do well to remember that most of the colonists, from whom we are sometimes asked to form our estimate of the Chinese nation, are drawn from the very lowest class of the populace, and as such exhibit, in perhaps an exaggerated form, most of the vices, with but few of the virtues, which distinguish the parent race; and it would be unfair to judge the entire nation from such unfavourable specimens.*

In our intercourse with Japan we have, perhaps, rather gone to the other extreme, associating a degree of intelligence and enterprise with its charming inhabitants which, if it has not excited in their minds an exaggerated sense of their own cleverness, must have impressed them very forcibly with the friendly interest we take in their efforts to equal, if not to excel, the most civilised nations of the West.

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* "A Chinese general, instead of executing, recently allowed, during five years, 80,000 youths to emigrate to Singapore, for terms varying from five to ten years, to give them the chance of retrieving their characters abroad."—*Consular Reports*, 1879.

I suppose we are all tolerably familiar with the startling transformations which have lately taken place in this far-off land. How these lively and intelligent people have seized on every point of our civilisation which, in their opinion, constitutes superiority—even to the extent of tall hats and black coats—with an eagerness which is almost amusing.

We now find representative institutions established in Japan, in the form of elective assemblies for the management of local matters, and we may soon expect to hear of fresh attempts at Parliament-making. Indeed, if recent news be correct, such a consummation is nearer than might have been thought possible. It is stated that the Mikado is in future going to rule as head of a constitutional Government, and that a National Assembly and a House of Peers is to be elected for the year 1890; while, to ensure some acquaintance with the forms and methods of procedure of such assemblies, ninety graduates from the School of Nobles, at Tokio, are to be sent abroad for six years to study the working of them in England, France, and America. It will be interesting to watch the operation of obstruction tactics, the *clôture*, and the caucus in Japan, where in time they will doubtless be introduced.

With the destruction of the feudal system disappeared the only organised force for the defence of the country, as well as for the maintenance of order; and one of the first measures of the new Government was the organisation of an army on a new footing. This was done by means of a conscription; the organisation and training having been for the most part entrusted to officers of the French army, which was then looked on as the most efficient military organisation in Europe. The creation of a navy was another necessity for a maritime State, and in carrying this out the Government copied the English system, availing themselves largely of the resources of this country in the construction of their fleet, and in the education and training of men and officers. But, according to reports emanating from a French source, it seems that some of the ironclads Japan purchased in this country have turned out the reverse of satisfactory. One indeed, which was classed as the most powerful in their fleet, has proved so unsound that it has been decided to break her up and sell the engines.

Japan has now at least two very complete naval establishments, and a magnificent dry dock at Nagasaki, capable of taking in war-vessels of the largest class. She has ironclads and Krupp guns, as well as training ships, which go on long cruises with future Japanese Nelsons. Japanese officers are serving at the present time in our own fleet: several have already done so, and the general opinion is that, as far as ability and zeal are concerned, these young men leave little to be desired. While, by way of a nucleus of a commercial fleet, there are several fine steamers under semi-official control, which carry the mails on their own coasts as well as to China, with occasional trips to more distant countries. The coast of Japan is now lit by nearly forty lighthouses, as well as lightships; buoys and beacons have been placed, and meteorological stations are to be established round the coast, if indeed they are not already in operation.

For the preservation of order, a police force of a semi-military character has been raised, organised, and even clothed on the European model, and numbers nearly 18,000 men.

Torture has been abolished, and a new code of laws framed on the basis of the "Code Napoleon;" while the law-courts have undergone a course of purification; but where dishonesty and corruption have prevailed for centuries, this process must be a slow one, and the task of training up a body of judges learned in the law, and who can be trusted to administer it honestly and fearlessly, is no light one.

The monetary system has undergone a complete change. Gold has been adopted as the standard, and a paper currency established.

The country has been surveyed and mapped with great precision, the longitude being computed from the meridian of Tokio.

The Japanese were quick to appreciate the advantages of rapid locomotion, and there are now two lines of railway in full working order, one of 18 miles, and another of 88 miles, while other lines have been projected and surveyed.

The development of the postal and telegraph system has been little short of marvellous. There are now some 4,000 post-offices, besides receiving agencies, street letter-boxes, money-order offices, and postal savings banks. The Postmaster-General issues his annual report, the same as in other countries, and when we read of some 23,000,000 letters, and over 7,000,000 post-cards, having passed through the post-office in one year, we may safely infer that the Japanese are fond of letter-writing; while, from the fact that during the same period nearly 8,000,000 newspapers were posted, and that the number of home newspapers sent through the post showed an increase of 46 per cent. over that of the previous year, it is evident that the native press is already a power in the State. It may be observed that Japan is now a member of the Postal Union.

Then, again, the telephone is at work between the public offices; while in connection with the Postal Department there is a training school for the mercantile marine, as well as a Board for the issue of certificates to masters, mates, and engineers.

No less remarkable has been the advance of the country in the matter of education, and there are now some two million children being taught in the schools, on the American and European systems. Education is under the control of a Government Board; but, besides those under State control, there are a great many private schools scattered about the country, which lose little in comparison with those established by Government; while, with a view to training young men for special professions, there are both schools and colleges in connection with the Departments of War, Marine, Public Works, Justice, Agriculture, and even of Colonisation.

The "Schools of Foreign Language," and "Medical Colleges," have done good work; and large numbers of promising students have been sent abroad at different times, to gain a higher education in special subjects; and although the knowledge acquired by these young men has, in many instances, been of a very superficial kind, numerous brilliant exceptions might be quoted; and the Government service has been largely recruited from their ranks.

In connection with education, a translation department was established some time ago, for the purpose of translating and compiling textbooks from foreign languages, and many valuable and useful works have been issued.

Nor has woman's education been neglected in the race for knowledge. A girls' school was opened some time time ago by the Empress in person, and this has been followed by others, where education is imparted both in Japanese and English.

It would be easy to extend the list of important measures initiated by the enlightened men who now control the destinies of their country; but to appreciate them fully, it is absolutely necessary to study the past history of the Empire; and I must refer you to the many able works which exist on this subject, the perusal of which will, I am sure, amply repay the reader.

That there has been a good deal of sensational talking and writing in connection with the recent changes in Japan, need scarcely surprise us; but, unfortunately, this has helped to encourage the notion that, while the Japanese have heartily embraced the Western type of civilisation, and are still pursuing the path of progress and development, the Chinese, on the other hand, are no more advanced than they were fifty years ago, and unfavourable conclusions have been drawn from this as to their mental capabilities. Talk to any one who has read about modern Japan, even if he has not been there, and he will speak in rapturous terms of a nation which has suddenly sprung from the darkness of the middle ages into a position—well, perhaps not quite—of equality with the most civilised nations of Europe, supporting his arguments by quoting the representative assemblies, educational measures, telegraphs, railways, and other marks of progress. And now question him about China, and this warm admiration and enthusiasm suddenly changes to a tone of cold contempt, for what he will likely enough call a stupid and uninteresting race of people, who are hardly worthy of being mentioned in the same breath as their clever go-a-head neighbours, the Japanese.

But there are many people well acquainted with the Japanese character, who, looking at the country otherwise than through the roseate hues of official spectacles, while warm in their admiration of what has been accomplished, of the patriotism displayed, and the earnest striving after real progress which has characterised many of the leading men in the country, have a different story to tell, warning us that all is not gold that glitters, and that a great deal of superficiality and striving after mere effect is mixed up with what we see and hear. A nation can hardly be expected to change its nature in a quarter of a century. It may change its skin—as, alas! has been the case in Japan; but one can hardly believe that the mass of the people have all of a sudden thrown off their old customs and modes of thought, and are now hungering wildly for compulsory education, School Boards, National Assemblies, excursion trains, and all the paraphernalia of European civilisation. There is no precedent for such a thing. And, without saying anything disrespectful of the people, or speaking disparagingly of the extraordinary revolution which has taken place, on the whole, so quietly, we may safely infer that there is a good deal of unreality in it all; that in many instances the shadow has been mistaken for the substance, the mere lacquer of civilisation for its reality; that, in fact, as a Japanese writer has himself declared, in a remarkable pamphlet advocating the introduction of Christianity, "Japan is delighted with the flowers and the fruit of the Western nations, but will take no account of the root."

It seems to have been forgotten that, until quite recently, the Japanese regarded the Chinese as their teachers in many things, willingly admitting that the high position to which they had attained was due in great measure to the teaching and influence of their neighbours. Indeed, the indebtedness of the Japanese to China and other countries for their language, their literature, and more especially their art, is neither so generally known, or so readily acknowledged, as in common fairness it ought to be. Up to within recent times—until, in fact, the formation of the present Educational Department—the education of a young Japanese was mainly founded on the Chinese classics, the history of China was taught in the schools, and the opinion obtained amongst the educated classes in Japan, as in China, that the best way to equip the young mind for the battle of life was by storing it with the works of Confucius. There was, in fact, but one standard, the Chinese classics, and these were almost as much admired and studied by Japanese scholars as they were in the land of Confucius. His four books of morals were some of the first things taught, and later on, the pupils were instructed in the various styles of Chinese learning. The city of Yedo was the great seat of Chinese learning. The language and literature of China first began to influence that of Japan in the third century, when an Emperor's son learnt to read Chinese books. But Japanese scholars only commenced the serious study of it when the works of Confucius were introduced; while the advent of Buddhism in the sixth century, followed by Chinese professors who had been invited over, gave an immense stimulus to the study of the Chinese language and literature, which became thence-forward almost the exclusive pursuit of many Japanese scholars. All the earliest Japanese printed books were mere reproductions of Chinese classical and Buddhistical works, and the system of printing from moveable types was borrowed from Corea, where they had been in use for more than a century. Native scholars admit that alphabetical characters were unknown among themselves, until introduced from neighbouring countries; and however much this indebtedness may be ignored by foreigners, it is acknowledged readily enough by many Japanese.

No less remarkable is the extent to which Japanese art has been influenced by that of China; and with the modern craze for things Japanese, which has converted grocer's shops into Japanese art depositories, and flooded the country with penny fans and inferior porcelain, this is in danger of being lost sight of. And the strange immobility and want of originality which characterised art in Japan for so many centuries is attributed to its practice and study having been confined, for some thirteen hundred years, to the aristocratic class; all the great Japanese painters up to a certain period having been gentlemen amateurs. But the sad thing in connection with Japanese art, at the present day, is its rapid deterioration since it came in contact with European civilisation, and the still sadder fact that, unless some fresh inventive genius arises, there will soon be no Japanese art at all. Overwhelming testimony points to the conclusion that Japanese art is now only admired and studied in other lands, and that the modern fever-heat of production at a cheap rate has driven the individuality and imaginativeness of the native artist out of the field. The attempt to produce art-work by machinery was reserved for this age of mechanical genius; but, as the results are totally wanting in imagination and character—the essentials of true artistic work—we shall perhaps in time come round again to the views so ably enunciated by Mr. William Morris, in his address recently delivered at the Burslem Wedgwood Institute.

In any comparison instituted between the two great Eastern races, the Chinese will undoubtedly be found to have the advantage; and it may be questioned whether the Japanese have ever originated anything to compare with the great principles which helped to build up the vast structure of Chinese civilisation, and to preserve it through a period covering the authentic history of the world. But China has far higher claims than anything based on mere superiority in the past. The country itself is larger than the whole of Europe. It contains everything necessary for the wants of its inhabitants. Its mineral resources are incalculable, the coal-fields alone having been estimated at over 400,000 square miles, or twenty times greater than those of Europe; while, side by side with this, iron ore of excellent quality is known to exist in almost every province, only waiting for the genius of the people to convert it to the manifold uses of modern life. For variety of climate and fertility of the soil, China is unrivalled. It is the home of cotton, sugar, and tea—the three great staples of modern commerce.

When we come to population, the mind is almost staggered at the figures we are asked to grasp. The last census gave the population at 396 millions, but the accuracy of this has been questioned by modern travellers, some of whom are of the opinion that 250 millions is a liberal estimate. On the other hand, it was recently stated by the Chinese Ambassador, at Paris, that the population of China was 400 millions. It is generally admitted, however, that every third person in the world is Chinese, or, in other words, that this extraordinary people constitute a third of the entire human race. Ingenious minds have even calculated that the Chinese are sufficiently numerous to form a belt ten deep round the globe.

But the peculiar and distinctive feature of the Chinese race, at the present time, is its extraordinary tendency to spread. There is hardly a country now which is not beginning to feel the wave of Chinese emigration beating on its shore; and this it is which marks out the Chinese as one of the great nations of the future.

Most people are aware of the extent of our own emigration, but few have any notion of the vast stream of Chinese emigration which is setting in every direction, flooding the eastern countries, and threatening to convert the Pacific Ocean into a Chinese lake. Dr. Williamson, a writer of long experience in China, has called attention to the fact of the Chinese being the great colonisers of the East, in a very striking way; he points out that there are immense tracts of country—continental as well as insular—comparatively untouched—in a state of nature:—

"By far the greater part of Assam, Cambodia, Siam, Burmah, Sumatra, Java, the Philippine Islands, Timor, Borneo, the Celebes, Papua, the Sandwich Islands, and others, literally millions of square miles, yet remain covered with jungle. The natives are comparatively a lazy and hopeless race, while Europeans fall before the insalubrity of some of these climates. The Chinese alone have proved themselves able to maintain vigorous physical life in these unwholesome regions, and they are entering these districts by thousands, and every year extending their points of emigration. There is hardly a tiny islet visited by our naturalists in any part of these seas, but Chinamen are found, and the probability is this will increase, and the natives will either fall before them, or become incorporated with them. It is clear that the Chinese will ultimately become the ruling spirits in these lands; and the same holds good with reference to Thibet, Mongolia, Manchuria, the north of the Amoor, and Asiatic Russia."

And the curious thing is, this tide of emigration is setting in strongly on the shores of Japan. There is scarcely an important seaport town now where the Chinese are not insinuating themselves into the various trades and industrial pursuits; your shoemaker, your tailor, and washerman are almost sure to be Chinese. The Japanese detest them; but what can they do when brought face to face with the capacity for business, the energy, industry, and indomitable perseverance of the Chinese, which carries success with it in every quarter of the globe? The Japanese are fond of a holiday—they take life easily, pleasantly, and not too seriously, and have no special aptitude for business. John Chinaman, on the other hand, never seems to want a holiday. Life to him means work—hard work; his wants are few and easily satisfied; he spends little and gathers much, and seldom loses an opportunity of pushing his business.

It is the same wherever we find them. In Siam the Chinese are literally taking possession of the country. An American writes from there, that "a large stream of immigration is flowing continually into Siam, and on arrival, the Chinese are by no means swallowed up by the Siamese nation. The stream is too large, and has too strongly marked features of its own, to permit anything of the kind. On the other hand, the influence of the Chinese upon the Siamese is so powerful that a strongly marked change is coming over the Siamese nation. The intelligence, energy, thrift, muscle—the motive forces of the nation—are more than half Chinese; one-fourth of the agricultural labourers are Chinese; three-fourths of the trades are Chinese. The large merchants, with scarce an exception, are Chinese, and almost all the handicrafts are Chinese. In some provinces, two-thirds of the inhabitants are Chinese, and only a small proportion of this vast immigration ever learn to speak Siamese fluently. They do not thoroughly affiliate with the Siamese, but are, on the contrary, inclined to clannishness, having a very poor opinion of the natives." Nor will this surprise any one acquainted with the Siamese character. When on a visit to Siam, I asked a gentleman residing in the interior what his opinion was of their mental capabilities. He replied laconically, "They only thought once a year, and that for the rest of the time their minds were a blank." To a visitor, Bangkok has all the appearance of a Chinese town, with a sprinkling of Siamese.

The same thing is going on in Cochin China, and in the neighbouring kingdom of Burmah, As regards British Burmah, there are at least 10,000 Chinese in Rangoon alone, where they do all the hard work of the place, and are gradually superseding the natives.

Carry the eye down the Malay Peninsula to Singapore, the great emporium of trade between the East and the West. Here the traveller first comes in contact with the extraordinary race which dogs his footsteps wherever he now goes, and on landing, he is appalled at the number of dolorous people with flat faces and elongated eyes, pig-tails, and roomy breeches, which meet him everywhere, and he may well believe himself to be in a Celestial city; for out of a population of 95,000, there are no less than 80,000 industrious Chinese, to whose energy and thrift the extraordinary development of this colony and its great prosperity is largely due.

But what is the surprise of the intelligent foreigner who has always heard so much of Chinese aversion to change, when he beholds Celestials in "billy-cock" hats, driving about in smart carriages, with coachmen in fine liveries; and, stranger still, Chinamen driving high-stepping horses in stylish dog-carts.

An unceasing stream of immigration is flowing into Singapore from Canton, the island of Hainan, and from Amoy: from the latter, as many as 18,000 Chinese have cleared in one year, and from Singapore, as a centre, they radiate in every direction, coasting along the Malay Peninsula to Burmah, flooding the native Malay States, building up flourishing settlements in the "Straits," and pouring a ceaseless stream of labour into the Dutch possessions. There are nearly 160,000 Chinese in Java.

While serving in a gun-boat in the East, I had occasion to call at every creek and river on the west coast of the Malay peninsula, from Singapore to Penang, and the very first human being I met at any of these places was a Chinaman, and the first sign of habitation, or of cultivation, was a Chinaman's hut and garden. Some humorous individual once remarked, that the infallible signs of advancing civilisation were, bottled beer, sardines, and high-heeled boots. I cannot answer for the high-heeled boots, but I shall never forget our surprise on finding bottled beer in Chinese stores, in obscure corners of the Malay States.

The chief attraction here are the tin-mines of Laroot and Singi-u-jon, which have been worked by the Chinese for years past with great success. In the Laroot country, out of a population of 33,000, in 1875, 26,000 were Chinese; and this was only a year after the faction fights which had reduced the population to 4,000. They seem content to live under any Government which is strong enough to preserve order, and which ensures them the quiet enjoyment of their rights; but it is questionable how long they will be willing to recognise the sovereign rights of the Malay rulers, who, with one notable exception, may be described, briefly, as a set of idle voluptuaries, living by the spoliation of their subjects. The Chinese have, on more than one occasion, already attempted the overthrow of the native Government, with a view to gaining possession of the mines, and, but for British intervention, might have succeeded. As it is, Great Britain virtually fulfils the disagreeable *rôle* of policeman for the Malay Rajahs, who have proved themselves incompetent to control the large and increasing Chinese population; and the question is forcing itself forward, whether the Malay peninsula is to be ultimately Chinese or British. The "Straits Settlements" are now virtually Chinese colonies under the British flag, and it seems that, whether we wish it or not, we shall have to accept, sooner or later, the protectorate of the adjacent native states.

Cross over to India, and you find the pig-tails creeping in there. At Mauritius the Chinese have long since monopolised the shops and small industries of the island. They have even penetrated to the West Indies and Demerara, where the planters, distracted by the fickle, idle disposition of the emancipated slave population and their descendants, are trying the experiment of importing Chinese labour.

In connection with the extraordinary emigration from China, it is often stated that the Chinese make bad colonists, because they do not bring their wives with them, and only come for the purpose of screwing what they can out of the country, to carry it back with them. This peculiarity is not, however, confined to the Chinese; while, as regards their wives, nothing is more extraordinary than the facility with which the Chinese adapt themselves to the land of their choice, and take to themselves wives from amongst the natives. This is the case in Japan, in Siam, and in Burmah, and the verdict of impartial witnesses is that John Chinaman makes a kind, careful, and industrious husband. But in America he finds a difficulty in getting a mate, for white women, as a rule, have a strong objection to marrying a man with a pigtail. Strange to relate, however, some fair daughters of Erin have become so fascinated with the celestial countenance as to accept the Chinese as husbands; but I have not heard how far the experiment succeeds.

It is often supposed that the greater proportion of Chinese emigrants, after amassing a competency, return home again. But very few are so fortunate as to do this, and although no doubt great numbers return to be gathered to their fathers, by far the larger proportion remain in the land of their adoption. Indeed, it may be questioned whether their native country would be able to contain, or to support, such an increase to the already dense population as would result from the return of so many colonists. The inducements are no doubt very great; indeed there is nothing more intolerable to the Chinese of all classes than the prospect of death and burial in a strange land, away from friends and family, on whom devolve, in the ordinary course of things, the care of the spirit of the deceased; a fact which explains the return stream of embalmed Celestials from America and other countries, and the vast sums expended in their transport. If the emigrant marries, and has sons, the inducements to return home are much weakened, the care of the spirit devolving on the male descendants.

But other reasons operate powerfully against any strong desire to return. John Chinaman knows full well that he can never hope to enjoy the fruit of his toil so peacefully in his native land as he can under British rule at least. A returned colonist is far too tempting a sponge to escape the "squeezing" propensities of some impecunious Chinese official, who soon finds the means of conveying a hint that a portion, at least, of his wealth might be advantageously directed to uses other than those intended. Thus it is that the tie which binds a Chinaman to his fatherland becomes loosened, and he settles permanently in his adopted country. And as to the complaint that the Chinese make bad colonists, they seem destined to be the hewers of wood and drawers of water for all mankind, and to be the great food producers of future ages. And they are admirably adapted for this sort of work, having no caste prejudices, or any of that false pride which deters a white man from doing manual labour in an Eastern land. In other respects they have long ago shown their extraordinary capacity for pioneering work, in the way of bringing fresh districts under cultivation. At the very dawn of history, as Dr. Williamson says, "we find them engaging in great engineering works—banking rivers, draining vast areas, and bringing huge tracts of country under cultivation. They have never fallen before the effeminacy of the natives, and they have the same spirit of enterprise, organisation, energy and thrift still."

With these startling facts of Chinese emigration before us, we can understand the cry of alarm which is coming from many quarters. But, as this influx is more likely to increase than to diminish as time goes on, and facilities of intercourse are increased, it is useless, in the face of it all, to exclaim that "John Chinaman must go back to his own country." In the first place, his own country won't hold him; and in the second place, he has planted his foot too firmly abroad to be uprooted, and in spite of abuse from all sides, supplemented by bills of exclusion, emphasised with brickbats and other marks of attention, he thrives amazingly, and it is certain that his departure would leave these countries the poorer, from the loss of so many thrifty, temperate, and industrious workers.

As to this flood of Chinese emigration being more likely to increase than to diminish in the future, there is no doubt about it. The tendency of modern civilisation is to diminish the causes of mortality and to prolong life. Natural causes, as well as internal troubles on a vast scale, have done much of late to keep down population in China. The last great famine carried off seven millions of people in one province, and the Taeping rebellion, which raged for eighteen years over the fairest provinces of the empire, devastating and entirely depopulating whole districts, probably destroyed little short of twenty millions, a number almost equal to the population of England. Remove these causes, and the surplus population of China must attain to alarming proportions, and it must find an outlet.

The opening of China to foreign trade, has of course done much to facilitate Chinese emigration, and the establishment of our great steamship lines have not only supplied the means of ingress to other countries, but given a well-defined course to this stream of emigration. We forced our way into China against the will of the people, with a result which was scarcely foreseen at the time. But the floodgates are open, and can never again be closed; and with these facts before us, is there not a touch of the irony of fate in the cry which resounds from many quarters, that "John Chinaman must go." Who have we to thank but ourselves, if, after battering at the wall of Chinese exclusiveness until the gates gave way, we find the stream which pours forth too strong, and that the rivulet is developing into a deluge. But what should we think of a person breaking in his neighbour's front door, because he refused to let him in, and had no wish to cultivate his acquaintance; and then, when his neighbour comes quietly to return the call, offering to mend his boots, make his clothes, wash his linen, and tend his garden cheaper than anyone else, receives him with bad language and rotten eggs, and proceeds to kick him out of the house. I think we should call such treatment unsympathetic, to say the least. And this is the view of the case the Chinese in San Francisco take; and when foreigners talk to the Imperial Government about their right to travel in China, and to the protection of native officials while prosecuting trade and other matters, the Chinese retort with biting force as to the treatment accorded to their countrymen abroad, pointing to the inconsistency between the preaching and the practice of foreigners in their dealings with China.

The facts I have stated in connection with the tendency of the Chinese race to spread seems to mark them out as pre-eminently destined to dominate over a large portion of the Eastern Hemisphere, as well as in vast districts where the climate is fatal to Europeans, and this makes the present and future of the Chinese nation a question of the deepest importance.

In instituting a final comparison between China and Japan, it may be asked, can anyone put his hand on a single spot on the globe and say, Here is a flourishing Japanese colony? Can any country be named in which the Japanese element is in the ascendant, in which it is increasing in influence, and assimilating other nationalities to its own type? Can any one point to any country and say, here a stream of Japanese immigration is flowing in; to any place where they are disturbing the labour question, or superseding the natives of the land?

As regards foreign intercourse with China at the present time, the one fact which obtrudes itself with disagreeable prominence is, that in spite of an intercourse extending over half a century, foreigners are still regarded by the Chinese with scarcely less dislike than they were in the early days of the factory at Canton. The official class, almost without exception, regard their presence in the country with but thinly veiled animosity, and are not slow to take advantage of popular discontent for the purpose of directing it against foreigners. Prince Kung is said to have told a foreign minister, in a fit of ill-humour, that, as men, we were as much disliked as opium; and although the sting of this remark is removed by a knowledge of the fact that the drug in question is already popular, and is daily increasing in popularity, there is no doubt that the treaty clauses providing for the inland residence and right of travel on the part of foreigners are highly distasteful to the officials, and that the mass of the people would view our departure with little regret.

How is it that, after a series of costly wars, in which, as we thought, Chinese exclusiveness was broken down for ever, and the insolence and pride of the Imperial Government humbled in the dust, that the nation still refuses the friendly hand, turns the cold shoulder on us, and declines to bite greedily at the plums of civilisation, like the Japanese? Why do the Chinese still hate us, and do all they can to thwart foreign schemes for the regeneration of their country.

That were indeed a question worth finding an answer to.

One might have thought that these defeats would have opened the eyes of the Chinese to the superiority of their conquerors, and that, even if deficient in gratitude for the chastisement inflicted, they would have welcomed the efforts which are now being made on their behalf. But such is not the case, and the reason is not difficult to discover.

These defeats are indelibly associated in the minds of the Chinese with what they considered high-handed and utterly unjust attempts to force distasteful measures on their acceptance. They had no desire for foreign intercourse—they were a self-contained people, living in a country which supplied all their wants, apart from the world, cut off from the "outer barbarians," and, as we say, wrapped up in their own conceits, and revelling in a supposed superiority to all the world. Certainly, they had no longing for a foreign trade, foreign visitors, or for Western civilisation, until the Powers came thundering at the gates, demanding admission, and compelling acquiescence in their demands. And what has been the result? Certainly, we have humbled their pride; but have these measures tended to friendly intercourse, or helped to draw closer the cords of alliance? On the contrary, the aversion of the Chinese to foreigners, or to foreign intercourse, is always obtruding itself, for in the eyes of the official class, foreigners are associated with all that is brusque and overbearing, and with schemes which, if adopted, would weaken their authority, and lead to disturbance and open rebellion, With the literary class, which constitutes by far the most powerful and influential party in the State, it is a question of intellectual pride. Measuring everything by the Confucian standard, they look with contempt on every branch of learning which is not included in this system, treating as ignorant barbarians all who are not versed in the Confucian lore. Hence their scorn for novelty in any form.

Our intercourse with China only shows how people may mix without amalgamating; how different nationalities may hold intercourse and trade with each other for years, without perceptibly assimilating. The status of foreigners in China at the present time may be explained by borrowing an analogy from the world of science. Chemistry teaches us to distinguish between a mechanical mixture and a chemical combination. In the first, we may compound various ingredients into a mass, without, however, altering the nature of the elementary parts, which may be separated again without difficulty. In the case of a chemical combination, the constituent parts are fused together, and the various elements are so completely absorbed into each other as to be one and indivisible. The action is often violent, causing noise and smoke. Cannot we trace somewhat similar effects in the fusion of races, a process out of which much heat and noise is often evolved?

In a magazine devoted to native affairs and foreign intercourse, published at Shanghai, a writer says, that "it seems an impossibility for the Asiatic and European races to rid themselves of prejudice, and to regard one another without any taint of aversion. In China, the proof of the dislike with which all foreigners are regarded is made evident every day. In every district into which they penetrate, epithets more or less objectionable have been applied to them; and even in Shanghai, where one would imagine they would be particularly welcome, and well received, a walk cannot be taken amongst the natives without the ears being assailed with cries from the children, or offensive remarks, of which it is wise, even for those who understand them, to appear ignorant." And the writer goes on to observe how "the officials are bland and winning to a degree in their communications with those with whom intercourse is inevitable, but they are always averse to anything like intimate relations; and, so far as I can learn, a footing of real intimacy, or even sincere friendship, has hardly ever been known between Chinese officials and Europeans."

Before we can hope to remedy this state of things, we must try to understand each other, and if we would win the Chinese to our own way of thinking, we must drop the style of noisy self-assertion, and adopt a more conciliatory tone. Proud of the achievements of the last fifty years, we sometimes blow the trumpet of science so loudly as to drown the notes of less sturdy musicians; but however much we may be enamoured of our own creations, it is scarcely reasonable to expect the Chinese, who boast of a civilisation dating back for thousands of years, to mount the hobby-horse of our mushroom civilisation, and to ride it to our own tune. We must endeavour henceforward to lead, instead of to drive; to understand the people by a careful study of their history, manners and customs, prejudices, and superstitions, instead of ridiculing them. And if foreigners pride themselves so much on their superiority, surely the first step towards a reconciliation should be taken by them; they can afford a little self-abasement without loss to their prestige.

In announcing some recent Assyrian discoveries, the distinguished explorer, Mr. Rassam, observed with reference to the finding of asphalte pavement, that he had always thought asphalte was a modern invention, and that its discovery brought to his mind the saying of Solomon, "that there is no new thing under the sun." But many surprises of this sort await the student of Chinese manners and customs, and his contempt soon gives way to respect and hearty admiration, for a nation which invented printing five hundred years before Caxton was born; which understood the use of the compass and of gunpowder before they were even heard of in Europe; which accurately recorded astronomical observations at the time of Abraham, and whose literature rivalled that of the ancient Egyptians in the days of Moses. He will find that the Chinese had an admirable system of canals before such things were known to ourselves. That pawnshops are more numerous, and the practice of raising money on goods more widely disseminated in China than probably in any country in Europe; that carrier pigeons, whose feats excited our admiration at the siege of Paris, have been used for centuries past, in conveying the names of successful candidates at the competitive examinations to their native towns; that while we are discussing the theory of the artificial culture of oysters, and pay dearly for "natives," this practical people have been obtaining good results for the last eighteen hundred years, and are said to have possessed artificial oyster beds before such things were even known to the Romans; and, still more remarkable, that artificial methods of rearing poultry have been practised by the Chinese for centuries, and while we experiment with incubators, they hatch ducks by the million every year, and teach the birds to be as obedient to their masters as dogs are with us. One thing more, the Chinese solved the problem which is passing for solution in an aggravated form, year by year, in all densely populated centres—the disposal and utilisation of sewage—in a thoroughly practical way centuries ago; and whereas the inhabitants of the greatest city of the modern world paid four millions for the privilege of depositing their sewage in the mouth of their great high-road of commerce, with an increasing annual expenditure; and while the papers are repeatedly telling us of the disastrous failures of sewage farms, constructed and worked at heavy cost, with the unfortunate result in some cases of converting the neighbourhood into an unwholesome morass, the Chinese, on the other hand, rid their great cities of all sewage matter, not only without cost to the inhabitants, but with profit to each householder.

I propose now to point out briefly the directions in which China has made a fresh departure of late years; for there is an idea that she has remained absolutely stationary, if indeed her movements have not been retrograde of late.

One undoubted result of the wars China has been engaged in with foreign nations, has been to open the eyes of the officials to their inferiority, in a naval and military sense, to the nations they professed to despise, and to the fact that if they are to maintain the unique position which they believe they have hitherto occupied in the civilised world, they must needs stoop to learn from the "outer barbarians," whose very existence they have been apt to ignore.

With a view to remedying a state of things so humiliating to the national pride, it has been the aim, for some years past, of certain of the most able and enlightened officials in the empire to place the naval and military forces of the provinces under their immediate care on a more satisfactory footing, so that, in the event of future misunderstandings arising with foreigners, China will be able to meet her enemies on more equal terms. Hence the vast warlike establishments which have sprung up in different parts of the empire—at Foochow, Shanghai, Nanking, and Tientsin—for the construction and repair of war-ships, for the manufacture of great guns and small arms, and for the supply of ammunition. Immense stores of war material have been collected at these and other points, vast sums of money having been expended in the purchase and erection of machinery and plant, while the workshops of Europe and America have been ransacked for heavy guns, rifles, ammunition, and all the paraphernalia of modern scientific warfare. Schools, colleges, and training-ships have been established, for the instruction of officers and men in the principles of modern warfare, and foreigners of all sorts have been freely employed in the construction, organisation, and general supervision of these establishments, as well as in the education of officers and the training and drilling of both land and sea forces.

Taking these establishments in order, we come, first, to the Foochow Arsenal, which is certainly a very remarkable institution. It was founded, some sixteen years ago, by a French naval officer, under official auspices, of course, and, in spite of the croakings of evil prophets, has been attended with a large measure of success. Failures and mistakes there have been, needless to say; but whether from inexperience, from attempting too much, or from native apathy, and the utter inability of Chinese officials to realise the degree of watchful care necessary to maintain a large industrial establishment of this sort in a high state of efficiency, we need not concern ourselves. The results achieved are, however, such as may encourage a certain amount of patriotic pride in the breasts of the Chinese officials who initiated so wide a departure from the traditions of the empire.

At the time I visited the arsenal, about 1,600 men were employed, but the number, of course, fluctuates according to the work in hand, and the state of the finances, which are not always very flourishing. These men were superintended by native foremen, trained in the arsenal, and I was informed by the chief engineer of the yard that they were as competent and trustworthy as Europeans, though certainly slower. The designs for the ships and engines were executed under European supervision, by native draughtsmen, trained in the arsenal schools, and I was given to understand they had thoroughly mastered the principles of wooden ship-building—that in fact the last vessel which had been built here had been built without any foreign assistance; and that, although mistakes had been made, the designers had given good proof of the value of the instruction they had received.

The workmen were drawn from different parts of the empire, and received from one shilling to as high as twelve shillings per diem. While on the subject of wages, I may as well mention some interesting facts, gathered from a report of the American Consul-General in China. Day-labourers, such as porters, wheelbarrow-men, and sailors, earn from 2½d. to 1s. 2d. a day; ordinary labourers make no more than 4s. 4d. per month; their estimated expenses for this period being 4s. Peasants earn from 4½d. to 7d. a day, and are fortunate if they can save 15s. out of this during the year. The best paid are the silk-weavers, who get from 4s. to 8s. a day. The average weekly wage, all over, is, for workmen, 6s., and 2s. for women and children. The necessaries of life are, of course, much cheaper than they are with us, and what we should consider hard fare, would be luxury to them. But we may safely infer that there is a good deal of plain living in China, though whether the high thinking follows in its train is perhaps doubtful. During the first ten years of its existence, 17 ships were built at the Foochow Arsenal, ranging from gun-boats of 500 tons to a screw transport of 1,450 tons, and including a powerful corvette of 1,393 tons, 250 horse-power, carrying 13 Whitworth guns. These vessels were built throughout of teak, imported from Siam; but arrangements have since been made for the construction of composite ships, with compound engines.

An important part of the original scheme was the establishment of schools, first, for the training of a competent staff of native engineers, draughtsmen, and naval architects, to take the places of the foreign *employés;* secondly, for the education of young officers for the navy, in connection with which there was a sea-going training ship, under the command of an English post-captain, assisted by two English officers of subordinate rank.

There was also at one time a department for the manufacture of chronometers and optical instruments, ship's compasses, &c., but this part of the scheme has been in abeyance for many years. The basis on which the entire system has been organised is characterised by a breadth of view and completeness which bears the highest testimony to the abilities of the talented founder and director, Mons. Giguel. Theoretically, the arsenal is controlled by a "commissioner"—a native officer of high rank, who, though doubtless well-read in the Confucian classics, is not always quite up to modern scientific requirements; and amusing stories are told about the ignorance of these great men in regard to the things under their charge; how one, for instance, on being shown the engine-room of a steamship, protested he was being made fun of, for, said he, all the engines he had ever seen before had a big wheel, and there was none here. But so long as a knowledge of the writings of Confucius is the sole qualification for Government appointments, we cannot look for a high standard of efficiency in dockyard management: the qualification, be it observed, consisting in the knowledge—not the practice—of the virtues inculcated by this great master; far otherwise.

The arsenal at Shanghai is organised somewhat similarly to the one at Foochow, and well equipped with all the requisites for the manufacture of heavy guns, small arms, and ammunition, as well as for the building and repair of ships. But this arsenal is mostly famous from the fact that here was constructed not only the very first, but the largest, wooden frigate that has ever been built in China. This vessel is 363 feet long, and carries 28 rifled guns. But what the Chinese especially pride themselves on is, that with the exception of the screw-shaft, every part of the ship and engines was made by native artisans, with only five foreigners to direct. The ship was launched about ten years ago, and a delightful story is told in connection with the ceremony. It seems that a foreigner, who was present on the occasion, ventured to remark to a native official that this was probably the largest vessel that had ever been produced in China; but he received a severe snubbing for his pains, the official intimating, in the politest possible way, that, for an intelligent foreigner, he displayed a remarkable ignorance of Chinese history, and that, if he would take the trouble of looking up the annals of the Ming dynasty, he would find that the Chinese had built ships large enough to carry the one just launched as part of their cargo. The ships in question, so we are told by students of this particular period of Chinese history, measured no less than 440 feet long and 180 feet broad, and performed feats of navigation for which we have no parallel. It is only right to add, that doubts have been cast on the veracity of the historians. But not content with this triumph of naval architecture, the Shanghai authorities determined to try their hands on an ironclad, and presently brought forth a remarkable turret ship, which has been facetiously dubbed by foreigners, "The terror of the Western nations."

We now come to the arsenal at Tientsin, which, from its position on the great high road to the capital of the Empire, as well as its proximity to it, would naturally be the chief source of supplies, as well as the base of operations for an army defending the capital. The arsenal is of considerable extent, and comprises a powder factory, gun factory, as well as foundries for the casting of shot and shell, and extensive machine shops. The departments, at the time of my visit, were under foreign supervision. In connection with the arsenal is a torpedo school, where native officers are instructed in the principles and practical application of torpedoes. Patterns of each sort, including those adopted by our own Royal Engineers, are collected here, and the entire apparatus for instruction and experiment has been supplied by a well-known firm of telegraph engineers on the Thames. Small torpedoes are frequently laid and fired by the students, who, it is needless to say, receive a thorough preliminary grounding in the principles of electricity, and are now, it is stated, thoroughly competent to lay down a system of defence in connection with the forts, for the protection of the river approaches to the capital. By a strange coincidence, a factory for the manufacture of small arms and ammunition has been established on the site rendered famous by the meeting of the high officials concerned in the ratification of a treaty of peace and commerce, well known as the "Treaty of Tientsin." One is reminded by this of the old adage, "*Si vis pacem para bellum.*"

Apropos of river defences, it is worthy of remark, that the Peiho forts, of painful associations, have been the object of increased solicitude of late years, having been entirely reconstructed on something like scientific principles, and heavily armed with Krupp guns; indeed, when I was at Tientsin, the Viceroy was said to have something over two hundred of these formidable weapons distributed between the various forts in the neighbourhood, as well as Gatlings, and a vast accumulation of war materials of all sorts. And not only have the approaches to the capital been fortified so far as to make them well nigh impregnable to a direct attack, but the other most vital points of the empire have received their due share of attention, more especially the river approaches to the different arsenals; and these defences have been supplemented by the purchase, in England, of a fleet of most formidable twin screw gun-boats, mounting guns equal in calibre to anything carried by our sea-going ironclads, by an ironclad recently launched in Germany, as well as by a large number of torpedo boats of the most approved pattern.

It might be supposed that these extensive war preparations, including the establishment of arsenals, and the construction and organisation of a fleet, were the outcome of some comprehensive and well considered scheme for the protection of the empire, emanating from the central authorities at Peking. Such, however, is not the case. Strange as it may seem, each arsenal, ship and fort, is the result of individual enterprise, directed solely to the defence of the particular province to which it belongs, independently of any protective measures undertaken by the authorities of adjacent provinces, or of any general scheme for the defence of the country, which the military wiseacres of Peking may be supposed to have elaborated in view of a foreign invasion. Such a strangely anomalous state of things of course precludes any joint action or concentration of forces, and leads to inconveniences of a most serious kind, as was brought to light in a somewhat strange fashion, when, some time back, it was proposed to assemble the naval forces of the empire for a series of manœuvres in the river Yang-tze. The enlightened official with whom the idea originated—not, be it observed, a member of the Chinese Admiralty, if indeed, they can boast of an equivalent Board for the management of naval matters—pointed out with truth that a Chinese fleet had never yet manœuvred in company, and that, without some drill in joint evolutions and tactics, ships fighting in company with a common enemy were as likely to run each other down as to damage the foe. The *Times* correspondent at Shanghai, in a very graphic account of the assembling of this motley flotilla of eleven ships, tells us how the evolutions were indefinitely postponed, until someone should decide whether the fleet was to be commanded by a Foochow or a Shanghai general, and that although the officers, both combatant and engineer, were Chinese, and that the ships were in fairly good order, the practical management of them was entrusted to gentlemen who, under some such *sobriquet* as Jim or Johnny, had been in the habit of piloting merchant ships about the coasts. The writer further pointed out a difficulty which the Chinese authorities, in their exuberance of spirits at having collected together such a formidable armada, would seem to have overlooked, namely, that from the fact of these ships carrying a mixed armament, comprising specimens of every known system of ordnance, there would be some difficulty in keeping them supplied with the proper kinds of ammunition. Whether the much talked of manœuvres ever came off, I can't say, but we must hope, for the sake of the jolly tars on board, as well as for their wives and families, that the ships remained quietly at anchor.

I mentioned that foreign officers had been employed to initiate the native troops into the mysteries of Western military tactics, and as a result there are so-called "foreign battalions" at Foochow, Ningpo, Shanghai, and Tientsin. The traditional system of tactics in the Chinese army calls forth a good deal of agility on the part of the troops, so much so that the movements of a native regiment on parade have been not inaptly likened to a sort of military can-can, so opposed are they to all our notions of military exercises. I enjoyed the privilege, on one occasion, of witnessing a review of the foreign drilled regiment at Foochow; and although under the sobering influences of an English instructor, the accustomed antics were dispensed with, a large amount of amusement was provided for the spectators. It was, indeed, a very wonderful performance; and considering that the officer-instructor was entirely ignorant of the native dialect, the state of efficiency and discipline to which he had brought his men was very creditable. But when I tell you that each order was emphasised with a sort of windmill motion of the sword-arm, you will understand the effect was remarkable.

The regiment at Ningpo has been trained by an American officer; that at Tientsin—which, by the way, is a field battery of artillery—by a retired officer of the German artillery, who informed me that the men were capital marksmen, but sadly wanting in military spirit. So that, on the whole, these "foreign-drilled" regiments can hardly be reckoned a very important factor in the military forces of the empire. It may be remarked that a Chinese soldier costs his country about £13 per annum.

An innovation of a very important nature, though in a different direction to the measures I have been describing, was the establishment of the "Foreign Customs' service," which has now been conducted for several years past by an English gentleman, well-known by name all over the East. I refer to Mr. Robert Hart, the Inspector-General, who has won for himself, and the department he so ably controls, the respect, as well as the entire confidence, of the Chinese Government. This important reform was introduced after our last war with China, and, to realise its full significance, we must endeavour to place ourselves in the position then occupied by the Chinese.

The returns furnished by this department, which are probably the only reliable ones supplied by any branch of the public service, give us some idea of the extent of the work done by it; and we learn from them that the foreign trade—export and import—for the year 1880, amounted to about 45½ millions sterling, returning a revenue to the Government of over four millions. Of this trade, about 73 per cent. was taken by Great Britain. As regards the revenue of China, it has been stated, on good authority, that, apart from the foreign customs receipts, the Government can always count on something over £50,000,000, and that possibly it reaches as high as £60,000,000; and, moreover, that this amount by no means represents the limits of the nation's paying capacity, the Chinese being, in fact, some of the highest taxed people in the world.

The throwing open of certain ports to foreign trade has had a result which was, perhaps, scarcely anticipated by the Chinese, namely, of transferring a large share of the coasting trade to foreign vessels. It has been stated that the introduction of our steamers on the coast threw, at least, 100,000 junkmen out of employment. Perhaps this estimate is exaggerated; but, in any case, the Chinese engaged in the coasting trade could hardly be expected to view such a disturbance of the commercial equilibrium with equanimity, and we may be equally assured that all who suffered by it have become bitter opponents to foreign intercourse. The threatened monopoly was especially unpalatable to certain high officials; and as they could not prevent foreign steamers from plying on the coast between such ports as had been opened by treaty, or even prohibit native merchants from availing themselves of the facilities thus offered, they took the only course that was open to them, namely, that of starting an opposition line, with a view to wresting the coasting trade, and influence accruing therefrom, out of the hands of the foreign companies. Funds were readily found for such a purpose, able natives, who had gained experience in the working of concerns of this nature, were placed in positions of trust; steamers were purchased, and a company was started under the auspices of one, at least, of the most powerful and enlightened men in the empire. And thus was inaugurated one of the most important progressive measures that has been witnessed in China of late years, and one, moreover, which, under proper guidance, may be the means of developing the maritime trade of the empire to an unlimited extent. In the first place, the company secured the monopoly for carrying the tribute rice, which, of course, gave them an immense lift. And soon after their fleet was augmented by the purchase of an American line of steamers, by which they not only rid themselves of formidable rivals, but wiped out the American flag altogether from the coast. The company took over the whole concern—captains and officers included.

The object which, above all others in connection with the undertaking, was dearest to the heart of the patriotic Chinaman, was the exclusion of foreigners from the concern. But in this they only partially succeeded, for the simple reason that there were no natives at all qualified to command the ships or work the engines. Foreign capital was kept out, and no foreigners were admitted to the management; but the company were, perforce, dependant on the hated barbarians for the officering of their ships, as well as in matters relating to repairs, and the various details connected with the successful working of a large steamship company.

The operations of the company have been confined hitherto to the coasts of China; but during the last few months, a most important step has been taken in the establishment of a line of steamers to run to England, with a native agency located in London, for the purpose of importing tea direct; the first ship having lately arrived in the Thames, with the members of the agency on board. Whether this line is in connection with the semi-official "China Merchants' Company," I have no means of ascertaining, but the scheme has been long talked of, though, like all others emanating from native sources, it has been pooh-poohed by foreigners. The idea of entering into competition with the magnificent vessels now running between London and China is a bold one, and it will be interesting to note the result. So far, I believe, the line consists of four ships only, some of which were recently built on the Clyde; but none of them are remarkable either for speed or size. They are manned by natives, but officered by Europeans. The idea of John Chinaman bringing over his own tea, has a flavour of novelty and enterprise about it; but, to ensure patronage, the company should open retail branches in the principal thoroughfares, in which case the temptation to buy the fragrant leaf from John Chinaman in his national dress, pigtail and all, dispensing it with his proverbial blandness of manner, would, I am sure, prove too strong for the average British matron to resist.

Another hopeful sign for the development of steam navigation in Chinese waters, is the fact that the proud literary class have so far conquered their prejudices as to avail themselves of the comfort and safety of the coast steamers, when proceeding to take part in the great competitive examinations; for, be it observed, although the Chinese abolished the feudal system, and destroyed caste two thousand years ago, a literary caste has since arisen, which has proved more detrimental to real progress than even official obstruction has done.

In the matter of railway enterprise, it must be confessed, China does not offer a promising field. The official and literary class make no effort to disguise their aversion to rapid locomotion, and for this reason the efforts which have been made from time to time by foreigners have invariably failed. And this dislike to railways is often quoted as a proof of China's backwardness in the scale of civilisation; but, as a well-informed writer in the *Nineteenth Century* recently observed:—

> "There are many sound arguments to justify the hesitation shown by the Pekin ministers in sanctioning such enterprises. It may be admitted that railways would give a great impetus to foreign trade, and that, consequently, the Chinese would derive as much advantage as any one else from their construction; but the Government is guided in its policy by other considerations as well as those of pecuniary advantage. Even without railways, Chinese commerce has reached a flourishing point, and it will be long before the Pekin Ministry will be induced to disturb the *status quo*, and incur possible dangers, for the sake of benefiting foreign tra

In justice to the more enlightened class of Chinese officials, it may be remarked that they view the question in a far wider sense than many foreigners give them credit for, and that the opposition on their part is not in every case based so much on an absurd dislike of change, as it is on higher and more important considerations, with which promoters of companies and foreign capitalists are scarcely likely to concern themselves. The Government of China, powerful and despotic as it is in many respects, is not, after all, so omnipotent or so popular with the masses, as to be in a position to ignore possible contingencies arising from the sudden facilities of travel, and for interchange of thought between distant cities and provinces with the attendant risks of rebellion, resulting from the introduction of railways. It is difficult for us, habituated as we are from infancy to the visible results of all the scientific inventions of the last fifty years, to realise the effect of such a revelation on the minds of an intelligent people, and we must excuse them for looking at these things in a different light to that dictated by commercial interests.

But there is another reason which carries great weight with Chinese officials, and that is their jealousy of foreign influence; for it is certain that, if railways were introduced, the lines would have to be surveyed and constructed under foreign supervision, and worked by foreigners for many years to come, as there are no natives at all qualified for this kind of work, and for this reason the officials would rather wait until they are in a position to construct the lines without foreign help. As regards the influential literary class, the fact that Confucius made no mention of steam-engines or railways is enough to excite their contempt for these new-fangled barbarian devices. And, after all, the reception accorded to pioneers of railway enterprise in our own enlightened land was not so universally enthusiastic as to entitle us to throw stones at Chinese obstructionists.

You are probably aware that a short line was actually laid down and worked for some months at Shanghai; and if the officials could only have been induced to leave it alone, would likely enough have been paying a dividend by this time. But their notions of propriety were too much shocked, and they took the first opportunity to pull it up, and to banish the entire plant to the Island of Formosa, punishing the unfortunate natives who had been beguiled into selling land for its construction. The proceedings in connection with this, the first and last railway in China, are now only a curious matter of history.

Irrespective of the opposition to railways on the part of the officials and *literati*, there are serious difficulties in the way of construction through densely populated districts, from the vast extent of the burial grounds, and the superstitions of the people—romantic and sentimental ideas with which railway engineers are hardly concerned, but which, nevertheless, exercise a profound influence over the minds of the people, and which, if disregarded, may lead to violent outbreaks of feeling. It is difficult for us to realise, in these scientific days, the absurd and morbid superstitions which hold undisputed sway over many of the best intellects in the country, paralysing all efforts in the way of progress, and discouraging any departure from the well-worn ruts in which the national mind has travelled so long. If the influential classes could be won over to the side of progress, and brought to see the advantage of railways, obstacles wonld vanish with marvellous rapidity; but so long as the officials and *literati* are hostile, nearly all efforts will prove abortive, and popular superstitions will continue to be flaunted in the face of innovators. Chinese who have been brought up in our colonies or in America, are thoroughly alive to the advantages of rapid locomotion, as well as of other scientific inventions; and it is amusing to hear the contemptuous way in which they speak of official obstruction. But one must not expect a nation numbering some three or four hundred millions, the vast majority of whom have never even heard of a railway, to welcome such an innovation. In time, no doubt, the influence of returned colonists will be felt, but for years to come, a scholar versed in the Confucian classics, or even a holder of the lowest literary degree, will be more respected and admired than the inventor of the locomotive, or the engineer of the finest railway bridge in the world. The Copernican theory was never more blindly combatted than is the introduction of mechanical inventions by the proud scholars of China, and years must elapse before the mild light of science can be diffused through the mental darkness which now prevails.

The history of telegraphs is scarcely more encouraging than that of railways, except that there are lines in actual operation under official control. The first was a short one, at Foochow, laid and worked by a foreign company, but it was subject to constant interruptions from the predatory habits of the natives; and the officials, when applied to for protection, pleaded their inability to control the people, whose conduct, in this case, happened to fall in with their own ideas as to the proper destination of "barbarian" property. When the officials took over the line, the depredations, of course, ceased. Another short line was erected at Tien-tsin, under the auspices of the Viceroy, and has lately, I understand, been extended to the forts at the mouth of the river. Whether any other official lines have been constructed, I am unable to state. But in the Consular Reports for 1880, mention is made of projected lines from Tien-tsin to Chin-kiang and thence to Shanghai, and from Nanking to Chin-kiang, the first of which, being under the superintendence of Li-Hung-Chang, only awaited the arrival of the material to be put up at once; this sudden spurt of enterprise, be it observed, resulting, as most others have done, from prospects of war with foreign powers, while even railways are being talked of again.

An important step in connection with telegraph enterprise was the establishment some years ago, of a school of telegraphy at Foochow, through the influence of the enlightened Viceroy, who, at that time, held the reins of office. It was conducted by the engineers of a Danish Telegraph Company, and a number of natives were there initiated into the mysteries of telegraphy. There is also a telegraph department at the Nanking arsenal, as well as a telephone, and machinery for making the electric light.

Present accounts from China speak of the opening and successful working of coal-mines, in two provinces at least, those in the neighbourhood of Peking being, it is said, likely to prove a complete success.* The company formed for working these is a purely native one, no foreigners being admitted into it; the necessary capital having been raised by the Chinese. It is anticipated that these mines will be able to supply coal, at a cheap rate, to the whole of the north of China. In one of the drifts, no less than six seams of coal have been cut through, one of which is seven feet thick. Coke ovens, and coal-washing apparatus, on an extensive scale, have been erected here; and gas-works, constructed at the colliery workshops, are now in full operation. A tramway has been laid in connection with a canal, and even a locomotive has been built to run on the tramway, as soon as native prejudices can be overcome.

There is also abundance of coal near the newly-opened port of Wuhu, on the Yang-tse, but for want of means of transport, thousands of tons which have been excavated are laying on the surface, deteriorating. In other directions, also, there are signs that the vast latent resources of the empire are being slowly developed.

One of the prime movers in these matters has been the famous Li-Hung-Chang, the Viceroy of the province of Chili, who is generally admitted to be an exceedingly able man, and anxious for the welfare of his country, according to his lights. He approves of railways, to a certain extent, and many other foreign inventions, admitting their usefulness under certain conditions; but in their application to China, I need scarcely observe, he is fully determined, as far as possible, to be independent of foreign help, and to keep out foreign influence. His proclivities are decidedly anti-foreign, which accounts for his wariness in adopting foreign inventions. I heard, on good authority, that all articles relating to China, in foreign newspapers, are translated for his perusal. These must give rise, at times, to strange reflections. He has been in the habit, for many years past, of going on his official rounds in a steam-launch, and has taken the greatest interest in the application of electricity to submarine defences; so much so, that on one occasion he was nearly hoisted with his own petard, in the shape of a torpedo which exploded prematurely. American steam dredgers have been at work for some years, deepening the approaches to the Grand Canal at Tientsin; and as a further proof of the Viceroy's appreciation of useful inventions, he sent an agent to Japan, to study the railways and the mining operations in progress there. Following the example of another high official, he is having his son taught English, and, judging from a specimen of his writing, the young man seems to be an apt pupil.

I hoped to have been able to give you some idea of the state of education in China, and to have sketched out a few of the reforms which have been initiated in this direction of late years, but the subject is far too comprehensive to venture even to break ground on at the present time. I can only remark briefly that Western science has already a great reputation amongst the few scholars of the empire who have been brought in contact with the better class of foreigners, and that there are signs, faint, few, and far between, certainly, when the vast extent of the country is considered, but still unmistakable signs, that China is swinging to the tide—a tide which, it has been well observed, no anchor of Oriental conservatism will ever be able to resist. The great and increasing demand for scientific books, as well as for instruction in scientific subjects, points to the same conclusion—that an intellectual revolution is approaching, and that in time the people will burst quietly through their old traditions, break their bonds asunder, and carry their rulers along with them.

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* Since writing this, the following telegram from China has appeared in the daily papers:—"The Kaiping coal mines have been closed, in deference to the opinion expressed by the censor, that the continued working of them would release the Earth Dragon, disturb the manes of the Empress, and bring trouble upon the Imperial family."

Suffice it here to remark that schools and colleges have been established, under official auspices, where education on the foreign system is being imparted; that a large number of young men have been carrying on their education for several years past in America, and that many of them have taken high places at Yale College, and that on their return this knowledge will be utilised in the service of their country; that several young officers have been studying in the naval establishments of England and France, and were serving till recently on board the vessels of the Channel Squadron; that there are Chinese who have mastered every new art and science which has been set before them, proving themselves to be intellectually quite our equals, and well adapted to receive the highest possible education we can give them. I should like to have brought to your notice the good results which have already attended these measures, by sketching out some of the careers of the young men whose minds have been furnished with the brightest weapons of our intellectual culture; and I think you would agree with me that a nation which is capable of producing them has a not ignoble future in store for it. No sketch of educational reform in China would be complete, however, without some allusion to the noble work which is being carried out in this direction by the missionaries, who, by every means in their power, are conducting a well-sustained attack all along the line on native ignorance, prejudice, and superstition, doing more, indeed, to break down the old exclusiveness, and to create respect for our civilisation and culture, than fleets or armies could ever hope to achieve.

Closely connected with education is the state of contemporary literature in China; and of the vast extent of the native literature, you may form some idea from the fact that the catalogue of the Imperial library, compiled about two centuries back, contains nearly 200,000 volumes, comprising works on every variety of subject; while as regards the far-reaching influence of this literature, the book language of China is understood by the educated, not only of the eighteen provinces of the empire, but also of Manchuria, Cochin China, Japan, Loochoo, Corea, and Cambodia.

Furthermore, some notice of the state of medical science would have been of interest, especially with reference to the noble work being done by foreign practitioners, both male and female, missionary and private, towards alleviating the appalling amount of suffering caused by the gross ignorance and incompetence of the native quacks. When I tell you that, until the arrival of foreign surgeons, there was not a native in the whole empire who could remove a tumour, treat an abscess, or even set a fractured limb with certainty, that, in fact, the science of surgery was a sealed book to them, you can picture the suffering daily and hourly endured by this patient people. And when we remember that even now there are no surgeons in the army or navy, it is easy to realise the amount of physical suffering that follows inevitably in the wake of a Chinese army. But it would require time far beyond the limits of this paper, as well as for abler words than mine, to do justice to these great subjects.

DISCUSSION.

Mr. PFOUNDES said the Society was much indebted to the distinguished officer who had favoured the meeting with his views. He must say he felt some diffidence in speaking on this subject in the presence of the Chairman, who had had so many excellent opportunities of becoming familiar with both nations referred to, and he would confine himself principally to Japan. He regretted that Lieutenant Shore had not been able to give any information with regard to Formosa, which was a country about which very little indeed was known, so that any details would have been valuable. It would be ungracious to criticise such an able paper; but he was sorry that Lieutenant Shore had put the Japanese so much below the Chinese, an opinion which, from some 13 or 14 years' experience amongst the former people, he could not quite agree with. His knowledge of the Chinese commenced in Australia, and was continued and extended in China; and his impression was that the Japanese were in every way superior, only they had not had so long intercourse with foreign nations, and the opportunities which the Chinese had thrown away. He thought it was a pity that a naval officer like Lieutenant

Shore had not given them some more details with respect to the arsenal, and other matters which he would be particularly competent to speak upon, and which would be of great interest to the readers of the Society's *Journal*; but no doubt he had reserved the more professional parts of his notes for use in some other way. Still, he believed the great use of papers read before the Society was to supply details on special matters by persons competent to treat them, which the public and those interested in commerce could not readily obtain. With regard to gold having been adopted as the standard, to his knowledge it never got largely into use in Japan; its use was mainly confined to the payment of foreign *employés*, and that only for a short time. He thought the Japanese had shown, in engineering, railways, telegraphs, and their adaptability to modern progress, a great superiority over the Chinese. In connection with the Translation Department in Japan, it was only right that the Rev. Mr. Werbeck's name should be mentioned, and he should not like such an eminent scholar to be passed over in silence. He could not agree in the statement that all the earlier Japanese books were reproduced from the Chinese; and as to Japanese art, he entirely disagreed with the views expressed in the paper. Lieutenant Shore had probably not had opportunities of mixing much with the people, or he would have obtained more accurate information. He might take to himself the credit of having stirred up some interest in art matters, and had started several societies in Japan, which, but for the political disturbances, would have done much more than they had in the study of art and archæology; but before long, he believed they would see a great revival of indigenous art in that country. In Australia, he knew something of the Chinese, and, as an Irishman, he must demur to the statement that only Irish girls would marry Chinamen, either in Australia or California. He thought the record of the eminently successful voyages of the *Vega* was about the most just and accurate account of the feeling in Japan, with regard to foreigners and foreign intercourse, which he had seen, after Sir Edward Reed's. He was sorry the French had undertaken to criticise the doings of the English; and he must say that while he was engaged for several years with the old Japanese Mail Company, he had the greatest difficulty in getting the French to move at all; and he actually had to induce the company to go to a heavy expense, in engaging a practical engineer to assist him in getting the work done at the arsenal. With regard to the Chinese arsenal at Tientsin, he must say that it was established by an old friend of his, Joe Taylor, an engineer, a man of considerable ability. With regard to the Japanese not being a colonising race, there were a dozen reasons to account for it, and it by no means followed that they would make worse colonists than the Chinese. The Formosan expedition, in the early part of it, was commenced as an attempt to colonise the outlying islands, and to start some method of moving off some of the more exuberant spirits from Japan; though he could not enter into particulars on that point, as the information he obtained was of a confidential character.

Mr. E. HEPPLE HALL said the main interest of the paper centred in China; and as Mr. Pfoundes had dealt principally with Japan, his remarks would have reference mainly to the former country, the older, and much the larger of the two. He had the more satisfaction in this, because he happened to be in China when the burning question of the hour was being discussed and settled, its colonising power. Although China was a very old country, and on that account interesting to the archaelogist and antiquarian, her great interest to Englishmen was, that she was coming to the front as a grand colonising power. She was breaking through the bonds of exclusiveness which had so long crippled her energies, and taking her place amongst the foremost nations of the world as a coloniser. He had hoped to hear something from the author about Formosa, but he presumed there was not time to deal with that part of the subject. They all knew that there was a complication, which seemed to grow more complicated, between China, Japan, and Formosa, and that in consequence of it we might see the two great branches of the Tartar and Mongol family at war before long, which would be a thing to be deplored, although the Western nations, not being implicated, might look upon it with equanimity. One point of great interest was the effect which the opening up of China would have upon the powers most closely connected with it, especially America. When he was in China, in 1868 and 1869, Mr. Burlinghame, the American Minister, was just leaving, and the American interest in China was thought to be on the increase; but he had not become aware that the Americans had gained anything by the advantages which they would seem to possess in the way of trade, in consequence of having the shorter route. It was thought that the States would gain considerable advantage over England in the trade with China, but these expectations had not, so far, been realised; on the contrary, England had a marked supremacy in trade, while her political, social, and moral status had considerably strengthened in comparison with America. Lieutenant Shore referred to the statement that the Chinese often made bad colonists, because they did not take their wives with them; but on that point he took the view of Mr. Pfoundes. The moral status of the Chinamen on the Pacific coast was not very high, and there had been every endeavour, during the last few years, to pass the most unjust and prohibitory enactments against them; but still he was inclined to think that the Chinese were really making progress. They knew that it was a tradition with the Western nations that their progress had been something like that of the crab, backwards or sideways; but when they found that Australia, Siam, the Straits Settlements, Borneo, and the whole Eastern world, were rapidly becoming colonised by the Chinese, they must take that fact into account as one of the features of the future. China was a great hive full of active, energetic, toiling, intellectual people, who were bound to impress their industry on the world for all time. Lieutenant Shore's knowledge of gunnery, and naval matters generally, gave him a special right to speak on questions respecting the arsenals, and the advance China was making in the art of war; but that was, after all, perhaps, the least interesting part of the paper. He spoke of the working of the coal mines as a sign of growth, which was no doubt the case. When he (Mr. Hall) was there, some attempts were being made to gather the coal by a sort of surface scratching operation, but he was not aware that any great progress had been made towards mining; in fact, he had understood that mining operations, as a whole, rested under the same disadvantages as railroads and telegraphs, and that mining was supposed to disturb the *fung shni*, and thus to interfere with the manes of the departed, so that it had made but very little progress. He must differ with Mr. Pfoundes as to the relative merits of the Japanese and Chinese. It seemed to him that the Chinese had an undoubted civilisation and history of their own; and though they did not show so much aptitude to adopt the civilisation of the Western world, they showed something much more valuable; they had such a civilisation of their own as they were perfectly content with, and they desired, as far as they could. to impress that civilisation on others. This he took it, was a sign of strength rather than of weakness. Those who had been thrown much amongst the Chinese must be aware of their wonderful capacity for work. While he was in Oregon and British Columbia, nothing struck him more than the aptitude exhibited by the Chinese, directly they landed, for all kinds of digging, quarrying, and other descriptions of manual labour. The first hundred miles of the California Pacific Railroad was built by Chinese; and nothing surprised him more than to see with what pertinacity this despised rice-eating people did their work. In that lay their great element of strength; and he desired to protest against the commonly received notion of the worthlessness of the Chinese as labourers. They were a wonderful people, which was proved by their habits of emigrating and colonising; and while not disposed to put them on a level with our own labourers, he thought we were bound, by every consideration of justice, to welcome them in our colonies as an industrious, hardworking, and temperate people.

Dr. Mann said it was only right for him to mention that the reason why some things did not appear in the paper was that, although the paper in its present state was rather longer than usual, and occupied quite as much space as the pressure on the pages of the *Journal* would allow at present; yet, as originally prepared by Lieutenant Shore, it was much longer, and contained many matters which it would have been very interesting to include, but which he had been kind enough to allow the excision of, for the present, though he hoped they would appear at some future time. He had had the pleasure of reading the paper in full, and he must say that the impression it conveyed to his mind was that there was a very clear and definite purpose about it, viz., to show that there was a reason why the Chinese had entertained so great an unwillingness to become intimately familiar with the habits of Western life, and it was a defence of them mainly on that ground which Lieutenant Shore had intended to put forward. It was a gratification that these two interesting nations had each had an expositor and defender that evening. But he would take the opportunity of protesting against a too common style of criticism which, when a gentleman brought forward the result of his own experiences, instead of accepting it gratefully, turned round and said, "Why had you not given us something else?" That was one of the easiest forms of criticism, but it was not very graceful or useful. It was always open to any one who thought anything had been omitted to bring it forward; but he did not think it was right to turn round on those who had taken the trouble to give the result of their experience, and say, "Why did you not give us something else?"

The Chairman, in proposing a vote of thanks to Lieutenant Shore said, in reference to the general scope of the paper and the criticism passed upon it by Mr. Pfoundes, he might say, as was said in the beginning of the paper, that a just estimate of the inhabitants of those distant lands, however desirable, was by no means easy of attainment, and anyone who ventured to give anything like a comprehensive view of what were called the characteristics of those two great Eastern races, might fairly be held excused if he did not enter into many minute details. An hour was utterly insufficient for such a task. In his opinion, Lieutenant Shore had touched on very many leading, interesting, and suggestive matters connected with those two countries, more especially with China. The Chinese had always been a conquering, dominating race in Eastern Asia; they had absorbed the greater part of the continent at one time in their history, and might do so again. No other race had so distinguished themselves as a governing, civilising, and conquering power, and their history extended over two or three thousand years. Now, such a people must have some very special qualities which were not commonly shared by the other races of Asia. It was well worthy of consideration what those qualities were, and in that view the paper had been very much to the point. There was not the slightest doubt that the Chinese had many of the elements which constitute a great nation. They were industrious, strong, thrifty, and had a fine moral philosophy—not perhaps inferior to that of Socrates or Plato. They based the whole of their social fabric on one of the fundamental laws of human nature, which was also one of the commandments which we ourselves obeyed, namely, "Honour thy father and thy mother, and thy days shall be long in the land." That certainly had been their fundamental principle, and they carried it up to the sovereign, who was represented as the father of the whole race. That spirit pervaded their whole life, domestic, social, and political. They respected, in the very highest degree, the parental relation, and that carried them through the greatest trials. They had been known to offer themselves to the most fearful tortures and certain death, to save their father or mother from danger, and it must be admitted that these were great and heroic qualities. With reference to a comparison between them and the Japanese, he was afraid he must differ essentially from Mr. Pfoundes. He had lived many years in both countries, and had been intimate with people of all ranks, and he was bound to say that the conviction he had come to was that the Chinese were very superior to the Japanese—superior in certain great moral qualities which had carried them far hitherto, and would carry them much farther, probably. They had great tenacity of purpose and perseverance; they had greater brain power than the Japanese, and, above all, they had greater ballast. Their contact with the Western nations had made less impression on them than on the Japanese. China was a vast colossus of a nation. It was the size of Europe, and contained more inhabitants. Some doubt had been thrown on the accuracy of the censuses, but there really was no sufficient foundation for it. There had been a series of censuses during several hundreds of years, and while the object of the Government would be to get the greatest number, the object of the people would be to return the smallest, because there was always the fear, in the East, of the poll-tax, or military conscription. There was not the slightest doubt that they numbered from three hundred to four hundred millions, and when it was remembered that they were surging over from their own land into all the Eastern Archipelago, stretching into the southern hemisphere on the one hand, and overland into Central Asia, which they long possessed, and although ousted from it during the time of their own trial by famine and insurrection, they had reconquered it from the other great power, the Russians, their power could not be doubted. There were three great powers now in Asia—the Chinese formed and always had been one; the Russians were another, somewhat more modern; and there was Great Britain, which possessed the great peninsula of India, with 250,000,000 subjects; and these three great powers dominated all Asia, as far as influence and power was concerned. He believed that China would prove a match for either, in staying-power, tenacity of purpose, and resources; and if even Russia or Great Britain should disappear from the East, China would still remain a great and a dominant power. It was impossible to assume that a people who had developed resources with the greatest possible industry, who were self-contained, who wore silk when our own ancestors were painted savages, who had given to the world tea—one of the greatest luxuries that ever came from Asia—who produced, within their own boundaries, all that was most prized in articles of commerce, had shown they were truly, not only self-supporting, but self-contained. They wanted nothing from abroad; they had their own philosophy, though it was true they borrowed their religion from India. That was the only one thing they ever had borrowed from abroad. They borrowed Buddhism, and maintained it, side by side with a State religion of their own, and it was really adopted partly for its ceremonial, and partly because it supplied a want, in offering them a hope for the future, which their own State religion did not. With regard to the Japanese, they were very enterprising, very artistic, and a very bold and courageous race. They had many excellent qualities, and they had absorbed the attention of Europe since 1862, when he first exhibited in the Great International Exhibition of that year, specimens of their artistic and industrial products. No one ever had an idea that there was such a treasure house of original motives of art, and such perfection of execution, in the East. They had given to the world one of the finest manufactures which ever existed, in lacquer ware. In porcelain they rivalled the Chinese, from whom they borrowed it. They had a good deal of originality in art, and had developed it for themselves, though they had borrowed it in the first instance, as they had nearly everything else. They borrowed the knowledge of the porcelain manufacture from China, and also their religion from the Chinese; they borrowed the Chinese language and Chinese philosophy; and their very art industry they took from China originally. To put them on the same level with the Chinese, therefore, even putting aside magnitude, and the power of effecting great things, was comparing very small things with great. The result of his life-long experience of both races, and he had great admiration for both, was that those who knew them best were least likely to speak evil of them. No doubt there were many things which did not assimilate with our ideas or feelings, but the fault was, perhaps, as much with us as with them. He knew no race in the world which was so little inclined to assimilate anything totally different from itself as the English. We might enter into cordial and commercial relations with other nations, but there was no assimilation, or anything like amalgamation, and, therefore, we had no right to reproach the Chinese or Japanese on that score. He believed there was a great future yet for the Chinese, as they had a great history in the past. Mr. Hall was perfectly right in saying that they were the great colonising nation of the world—the pioneers of the future. They seemed destined to become the "hewers of wood and drawers of water" for the whole world. He conceived that the attempts even to cast them out from California, and to put back the wave of emigration, would fail as much as Mrs. Partington's mop did to stop the Atlantic. The whole Eastern Archipelago would, at no distant period, be colonised by them, and all that had really been done in those vast regions down to the Australasian Colonies, except what our own race had done, had been effected in a great degree by the Chinese labour. They had the power of resisting all changes of climate; and he did not believe the Central American Railway would ever have been made, upon which the whole future fortunes of the Californian States depended, if they had not got 10,000 Chinese labourers to make it. The white labourer was first tried, and extraordinary wages were given, but everything broke down. The navvy was very excellent when at work, but, unfortunately, he would get drunk two or three days a week; and if you tried to keep him to his contract he said he was not a slave, and would throw up his employment; but if you made a contract with a Chinaman, if he undertook to do a certain task of work in a certain time, he did it. When they had the 10,000 Chinese on that railway, there never was a stoppage or failure of contract until the work was done. He thought the Americans were a little ungrateful for all the services the Chinese had rendered them. All the drainage of the swamps, which had given them hundreds of thousands of acres of fertile land, had been the work of Chinese. Taking their numbers and our own, it did not require to carry one's views very far into futurity to see that there would be eventually two races which would occupy the greater part of the world—one was the English speaking race, which had already filled North America, and stretched into the Australian continent and the surrounding islands, and would very soon count up to 200 millions, and the other was the 400 millions of Chinese. It seemed as if the greater part of the world would be chiefly occupied by these two races and languages, before many centuries.

The vote of thanks was carried unanimously, and the meeting adjourned.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, April 27, 1882; Professor Chandler Roberts, F.R.S., in the chair.

The paper read was—

THE MANUFACTURE OF STEEL AND INGOT-IRON FROM PHOSPHORIC PIG-IRON.

By S. G. Thomas and P. C. Gilchrist.

Lord Palmerston's terse and accurate definition of dirt as "matter in the wrong place," may with singular appropriateness be applied to the phosphorus, which, while itself a substance of considerable commercial value, is, unfortunately, so generally associated with iron ores, to the great detriment of their utility and value.

Dephosphorisation is the attempt to relegate this wrongly placed matter, if not into its right place, at least into a neutral position, where it can do no active mischief. The actual importance and scope of dephosphorisation in its application to steel-making, is most readily realised, if we bear in mind—

1st. That on a rough estimate about nine-tenths of the whole deposits of iron ore in Europe contains more than one part of phosphorus for every thousand parts of iron.

2nd. That in the smelting of iron ore in the blast furnace, to form pig-iron (the first step in the conversion of iron ore to a malleable material), no phosphorus is removed, so that, practically, all the phosphorus found in the ore is found also in the pig.

3rd. That in neither of the two great steel-making processes, as ordinarily carried out, is phosphorus removed; so that all the phosphorus found in the pig is, under ordinary circumstances, found also in the steel into which it is converted.

4th. That the presence of more than one part of phosphorus in a thousand of steel is not permissible (subject to the qualifications hereafter referred to) where reliable quality is necessary, phosphorus, as is well known, causing in steel extreme brittleness at ordinary temperatures.

Like all general assertions, each of these statements requires some amplification and qualification.

With regard to the exact proportion between the phosphoric and non-phosphoric deposits of ore in Europe, our estimates must be, of course, to a certain extent, conjectural and open to error.

Of the eighteen million tons of iron ore raised in 1880 in England, a trifle over three million tons, or about one-sixth of the whole, were non-phosphoric (by which is meant that they do not contain over one-part of phosphorus for every thousand parts of iron).

In other words, five-sixths of the whole amount raised was unfit for steel-making, without some process of dephosphorisation. But this fraction is far from representing the actual proportion between the available deposits of the two kinds of mineral, for whilst the high price of hematite ore causes every known deposit to be exploited to its maximum extent, the hitherto relatively low value of phosphoric ores has not rendered it profitable to work, except to a very limited extent, some of the largest deposits. The non-phosphoric ores are confined in England to Cumberland, Lancashire, the Forest of Dean, and two or three other very limited areas, such as Weardale, Mwndy, and the North of Ireland.

On the other hand, the whole of the ores of Scotland, Yorkshire, including the vast deposits of Cleveland, with its annual out-put of over six and a half million tons, North and South Wales, Shropshire and Staffordshire, and the great belt of country, extending from Wiltshire, across Oxfordshire and Northamptonshire, to Lincolnshire. These deposits are of so enormous an extent, as to render it very difficult to calculate their probable contents of ironstone; but an attentive examination of their areas justifies the conclusion that the non-phosphoric ores are, in Great Britain, at least ten times more abundant than the purer kinds.

Mr. Lowthian Bell, than whom there could be no more competent authority, some years ago, estimated the proportion as eight to one; but this was before the great extent of the Northamptonshire and Oxfordshire ironstone fields was so fully ascertained as it is. On the Continent also, all the largest deposits, with the exception of those of Spain and Sweden, are phosphoric. The great phosphoric ironstone region shared between Luxembourg, the Meurthe and Moselle, Alsace-Lorraine and Belgium, is alone more considerable than all the other deposits of Northern Europe together.

In America the deposits of Bessemer ore are very large, but are greatly exceeded in magnitude by the great phosphoric ore tracts of Pennsylvania, Tennessee, and Virginia, and it is highly probable that the centre of the steel manufacture of the United States will on this account gradually gravitate southwards. The fact that when iron ores are smelted in a blast furnace, the whole of the phosphorus they contain will pass into the pig-iron produced, is too well known to require insisting upon. The only exception is in the case of a few small furnaces which, while producing a particular quality of iron, will, when working on certain highly phosphoric ores, allow a trifling quantity of phosphoric acid to escape unreduced with the slag, though still producing a highly phosphoric pig-iron. Nor does it seem at all probable that in the blast furnace, which is pre-eminently and necessarily a reducing, as opposed to an oxidising apparatus, that there is the slightest chance that the conditions can ever be so altered as to allow of any appreciable removal of phosphorus taking place in the manufacture of pig-iron.

The attempts that have been made to purify the ore before its introduction into the blast furnace—of which the only partially practicable one is Jacobi's—have also hitherto entirely failed of commercial success.

The average proportion of phosphorus in our best known varieties of pig-iron may be taken roughly to be as follows:—Cleveland, 1·5 per cent.; Scotch about 1 per cent.; Lincolnshire, 1·25 per cent.; Staffordshire cinder-pig, 2·5 per cent.; Staffordshire mine-pig, from ·5 to 1 per cent.; Northamptonshire, 1·5 per cent. and over. It will thus be seen how far removed all these varieties of pig-iron are from the non-dephosphorising steel-maker's type, which, as we shall see, must not contain more than one-tenth of 1 per cent., or one part in a thousand of phosphorus.

The fact that, till the year 1878, in neither of the two great steel-making processes, the Bessemer and Siemens, was phosphorus in the slightest degree removed, is also a matter of universal knowledge. In puddling, on the other hand, it has long been known that from 80 to 90 per cent. of the phosphorus present in the pig-iron could be removed without difficulty. Thus, Cleveland pig-iron, containing 1·5 per cent. phosphorus, will make a puddled bar containing little more than one-tenth of this amount.

We should not forget, however, that there is a third great system of steel-making—the crucible steel manufacture, based on the cementation process. As this, however, starts with iron which has already been dephosphorised and decarburised by the puddling or some analogous process, it may be disregarded for the present purpose, with the remark that no better material for the manufacture of crucible steel could be obtained than the highly purified material, which it will be shown can be so readily produced by the new Bessemer process. The proportions of the several kinds of steel manufactured in 1880, are estimated by the able Belgian metallurgist and statistician, Monsieur Trasenster, to have been as follows:—Bessemer, 81 per cent.; Siemens, 16 per cent.; crucible, nearly 4 per cent.

It has been said that the presence of more than one part in one thousand of steel is fatal to good quality; this, too, needs some explanaion and qualification. Steel may be roughly divided into three classes: hard steels, rail or medium steels, and soft steels. In hard steels, containing one-half per cent. of carbon and more, the presence of so much phosphorus as above-mentioned is highly prejudicial, rendering the material absolutely unfit for the manufacture of all the better class of tools.

In rail steels, one part in one thousand is considered in England quite as much as should be tolerated, though when the carbon is as low as one quarter per cent., half as much again may be carried with safety. In fact, in America, the average home-made rails do not contain less than one and a quarter parts of phosphorus per thousand. Many of the Continental rail-steels also contain one and a quarter per thousand of phosphorus and more; this being rendered comparatively safe by the fact that foreign engineers prefer rails with a lower contents of carbon than is admitted in England.

The Terrenoire Company and others, taking advantage of the fact that phosphorus is less dangerous in proportion as the amount of carbon in the rails is less, have, indeed, produced rails with two thousandths of phosphorus and very low carbon, which, in ordinary climates, are sufficiently reliable. For soft steel and ingot-iron, containing less than two thousandths of carbon, which is now so largely used for manufactures other than rails, such as plates, wire, angles, rivets, sheets, and general purposes, it is also extremely desirable to keep the phosphorus lower than one per thousand. For good quality of boiler-plates and other special purposes half this amount should be considered as a maximum. Indeed, it may be taken as a rule that the lower the phosphorus, the higher the quality. It is thus seen that in admitting one-tenth of one per cent. of phosphorus as the average maximum allowable for good steel, we have, if anything, given a high limit.

It is now possible to appreciate more exactly the grounds for the statement, that at least 85 to 90 per cent. of the iron ores of Great Britain, and probably nearly the same proportion of the whole known ore deposits of the world, are unavailable for steel-making, without a practicable process of dephosphorisation. In order to grasp more fully what this means, it may be well to examine into what forms the crude iron which is annually produced is transformed before it passes into consumption.

For this purpose, Monsieur Transenster's figures may be again quoted. Assuming the world's production of pig-iron to be nineteen millions seven-hundred thousand metric tons, approximately five and a quarter million tons are consumed in the manufacture of steel, nine million tons in the manufacture of iron, and five and a half million tons in the production of castings. Again, taking Mr. Jeans's figures for Great Britain, it appears that of the 8,370,000 tons of pig-iron made in England, about two millions were employed in the manufacture of steel, and nearly three millions in the manufacture of puddled iron.

Now we have it on the authority of Mr. Edward Williams, the late President of the Iron and Steel Institute, an iron and steel maker of wide and varied experience, that the consumption of coal in manufacturing steel rails from pig-iron was during a series of years a trifle over one-third of that employed in the manufacture of iron rails, while the wages cost for manufacturing steel rails is only 28 per cent. of that necessary for the manufacture of iron rails.* While there is no doubt that the economy of fuel and labour in the manufacture of steel, as compared with that of iron, is more conspicuous in the case of rail-making than in most other departments of manufacture, the figures above quoted may be taken as closely approximating to the truth in all cases, as, while puddling has, comparatively speaking, stood still for the past ten years, economy in steel-making has made rapid progress. How, then, does it happen, that there are nine million tons of pig-iron annually turned into the unquestionably inferior material known as puddled iron, while only five and a-half million tons are converted into the superior form of steel or ingot iron, particularly when so great an economy of fuel and labour could have been effected by turning the whole into the higher-class material? May it not be fairly contended that it is really nothing but the absence of a practical and economical system of dephosphorisation that could justify the existence of such an anomaly? It is now proposed to show that there is no reason for its continuance, since the developments and modifications introduced during the last four years enable steel of any desired purity, as regards freedom not only from phosphorus but from silicon and sulphur, to be produced readily and economically from the most highly phosphoric kinds of pig-iron.

The Bessemer process, with concurrent dephosphorisation as now regularly practised at the Eston works of Bolckow, Vaughan, and Company, who, under the able guidance of Mr. Windsor Richards, have been the pioneers of the new industry, and 13 other works in France, Belgium, Germany, Austria, and Russia, is carried out as follows:—

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* *Journal of the Iron and Steel Institute*, p. 435.

The Bessemer vessel is lined with magnesian lime, which has been previously subjected to an intense white heat, and so brought to a condition of density, tenacity, and hardness, as far as possible removed from the condition of the material generally known as well-burnt lime, and more closely resembling granite, or flint. This material, which for brevity is known as shrunk lime (as in course of preparation it shrinks to one-half the bulk of ordinary lime), is used either in the form of bricks, or in admixture with tar as a rammed or slurry lining, this being substituted for the ordinary silica brick or silicious ganister lining of the hematite process. Before the metal, which may be either employed direct from the blast furnace without intervening re-melting, or, if for any reason this is not convenient, may have been re-melted in a cupola, is run into the converter, from 15 to 18 per cent. of its weight of common well-burnt lime is thrown into the vessel. The metal is then introduced, and the charge is blown in the ordinary way to a point at which the ordinary Bessemer operation is stopped—that is, till the disappearance of the carbon, as indicated by the drop of the flame.

The dephosphorising process requires, however, to be continued for a further 100 to 300 seconds; this period of so-called after-blow, which would be prejudicial both to quality and yield in the ordinary process, being with phosphoric iron, under conditions permitting of the removal of phosphorus, that in which the great bulk of the phosphorus—down, indeed, to its last traces—is removed.

The termination of the operation is shown by a peculiar change in the flame, and checked by a sample of the metal being rapidly taken from the turned-down converter, flattened under the hammer, quenched, and broken so as to indicate by its fracture whether the purification is complete. A practised eye can immediately tell whether or no this is the case. If the metal requires further purification, this is effected by a few seconds' further blowing.

The operation is thus, as will be seen, but little different from the ordinary Bessemer process, the differences that have been indicated, viz., the lime lining, the lime addition, and the after-blow, are, however, sufficient not only to enable the whole of the phosphorus, which would be otherwise untouched, to be completely removed, but the silicon, of which inconvenient and even dangerous quantities are occasionally left in the regular Bessemer process, is also entirely eliminated, while at least 60 per cent. of any sulphur which may have been present in the pig is also expelled. It is found, too, that the once formidable phosphorus is of most substantial assistance in securing, by its combustion, the intense heat necessary for obtaining a successful blow and hot metal.

If it is desired to produce ingot-iron, or a metal differing only from puddled iron by its homogeneity and solidity, the usual recarburising addition of spiegel is omitted, or replaced by half a per cent. of rich ferro-manganese, which represents a considerable economy as compared with the cost of the spiegel necessary for the manufacture of harder steel. The phosphorus is oxidised by the blast-forming phosphoric acid, which, finding itself in the presence of two strong bases, oxide of iron and lime, unites with the latter of them to form phosphate of lime, which passes into the slag. Whether or no there is a transitory formation of phosphate of iron, the oxide acting as a carrier, is a matter, though interesting theoretically, which it is needless here to discuss. The order of the removal of the several impurities is well indicated by the diagrams (see pp. 653, 654, 656, 657), for which we are indebted to M. Meyer, of Luxembourg, and M. Massenez, of Hoerde.

It will here be seen that, in the first stage of the operation, phosphorus is the substance which is least attacked, while, as the blow advances, and particularly after decarburation, its removal becomes more and more rapid. The contrast between the two operations—representing an ordinary hœmatite blow, examined by Mr. Snelus—is most noticeable in the phosphorus curves. In the one, the proportion of this element slightly but distinctly increases from the commencement to the end of the operation. In the other, the removal, at first slow, becomes eventually rapid, till ultimately it is entirely at the discretion of the operator, whether more than one part in five thousand shall remain. As an instance of the purity of the metal that can be at will produced from a pig-iron, such as is ordinarily made in Scotland, Staffordshire, and Lincolnshire, we may quote analyses* made so long ago as the spring of 1880, at Seraing, of steel made at Wittkowitz by the Basic process.

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* *Journal of Iron and Steel Institute*, 1880, p. 115.

	Silicon.	Carbon.	Sulphur	Phosphorus.	Manganese.
Plate No. 1....	·000	·04	·01	·008	·29
Plate No. 2....	·000	·09	·01	·014	·29
Square Bar....	·000	·06	·01	·011	·26
Round Bar....	·000	·06	·01	·00	·36

It will be seen that these bear comparison with even the phenomenally pure Bessemer steel of Sweden, of which the following is an average analysis as given by Akerman:—

Silicon.	Carbon.	Sulphur.	Phosphorus.	Manganese.
·017	·1	Trace	·028	·15
to	to	to		to
·029	·3	·01	·031	·25

The Basic-Siemens and Siemens-Martin processes are carried out on the same lines as the Bessemer process. The dephosphorisation is very complete; but the operation takes about five per cent. longer time than when pure material is used; the proportion of lime required is less than in the Bessemer process, and the wear of the Basic hearth, with suitable arrangements, is not excessive. The limits of time, and your patience, render it necessary for the present to postpone the detailed consideration of this very interesting and important branch of the subject of dephosphorisation, and to confine our attention to the Bessemer process, in which, moreover, most of our experience has been gained; though many thousands of tons of steel have dephosphorised by the Basic-Siemens process, which is now in regular operation at two continental works.

It cannot be too clearly understood that, among the chief features of dephosphorising Bessemer process, are, first, its controllability, and, secondly, its peculiar suitability for the manufacture of soft steel or ingot-iron. Its controllability seems especially to depend upon the fact that, while phosphorus remains, it apparently exercises a protective influence on the iron, and so to prevent the tendency to red-shortness, which demands so much skill to avoid in the regular Bessemer process. On these points we cannot do better than quote the opinion of M. Walrand, who has had a long experience of both processes at the great steel-works of Creuzot.* M. Walrand expresses himself as follows:—

> "Those who are occupied in the manufacture of Bessemer steel know how difficult it is to obtain, with regularity, the extra soft steel employed for boilers in the French navy. Such metal appeared only to be made in the Martin furnace, and even then it was necessary to employ picked material in its manufacture. But by the new Bessemer dephosphorising process, steels of an extraordinary degree of softness can be obtained with the greatest facility, and at a price less than that of ordinary rail steel. By treating a pig containing from 1·5 to 2 per cent. of manganese, we obtain, after the decarbonisation and dephosphorisation is finished, a non-oxydised metal, which does not contain more than traces of carbon or manganese. If it be desired that the steel should be entirely free from any tendency to red-shortness, we may add from 0·25 to 0·50 per cent. of a rich ferro-manganese, to remove any traces of oxygenation. The only precaution to be taken to obtain a soft steel, is to choose pig (if direct working be employed) which contains sufficient manganese (with 2 per cent. as a maximum), or to make a suitable mixture of pigs, if cupolas be employed. But this will be by no means the only outlet for dephosphorised metal; for up to the present time, the high price of soft steel has been the great obstacle which has prevented many people from employing it in construction. But by the new process, soft metal can be produced at a less price than ordinary puddled iron; there is, therefore, no longer any reason, apart from routine, why steel should not be employed in all cases in place of iron, to which it is so much superior in strength."

It is, however, to be borne in mind, that in the manufacture of rails no attempt is made to push the purification beyond the point at which the composition of a good rail steel is attained. Critics, not understanding this, frequently ask, Why is not Basic rail steel as pure as the Basic plate steel, made at Wittkowitz? The obvious answer is, that to carry the dephosphorisation and desiliconisation of steel intended for rails to its maximum extent would be wasting time and material. As an example of the ordinary quality of steel which is manufactured for rails, there is added in the Appendix a table of analyses of fifty consecutive blows, recently made at Eston, from Cleveland pig-iron, in the course of their regular practice.

With regard to the pig most suitable to the

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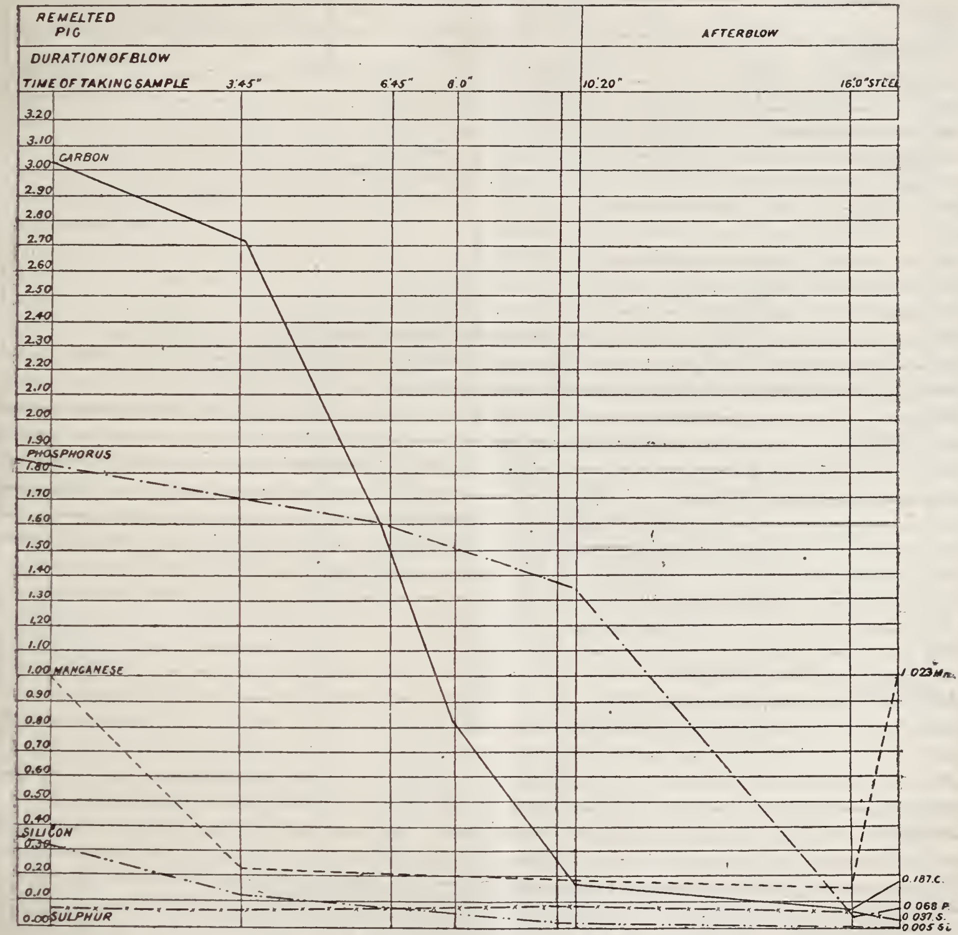
* "Révue Universelle des Mines." 1881, p. 422, vol. x.

Basic-Bessemer process, there are very few kinds of iron which cannot be successfully used; though, on the other hand, there are some which give specially good results. The only partial exception to be made is in the case of pig-iron, which contains materially over three-tenths per cent. of sulphur, or over two and a quarter per cent. of silicon. Though even pig of this composition can be readily treated, if subjected to a preliminary desulphurising or desiliconising process. The ideal dephosphorisers' pig has a composition falling roughly between the following limits :—

Silicon	·5 to 1·8	per cent.
Phosphorus	·8 to 3	,,
Sulphur .... under	·3	,,
Manganese not over	2½	,,

Some of the best results have been obtained with iron which contains about 3 per cent. of phosphorus. The most suitable British iron is that of Scotland, Lincolnshire, and Staffordshire. The cinder pig of Staffordshire, which is high in manganese and phosphorus, and low in sulphur, is a very fair example of a good Basic-Bessemer pig.

Diagram I., showing the Elimination of Elements in the Basic Converter, by M. Meyer of Luxembourg.

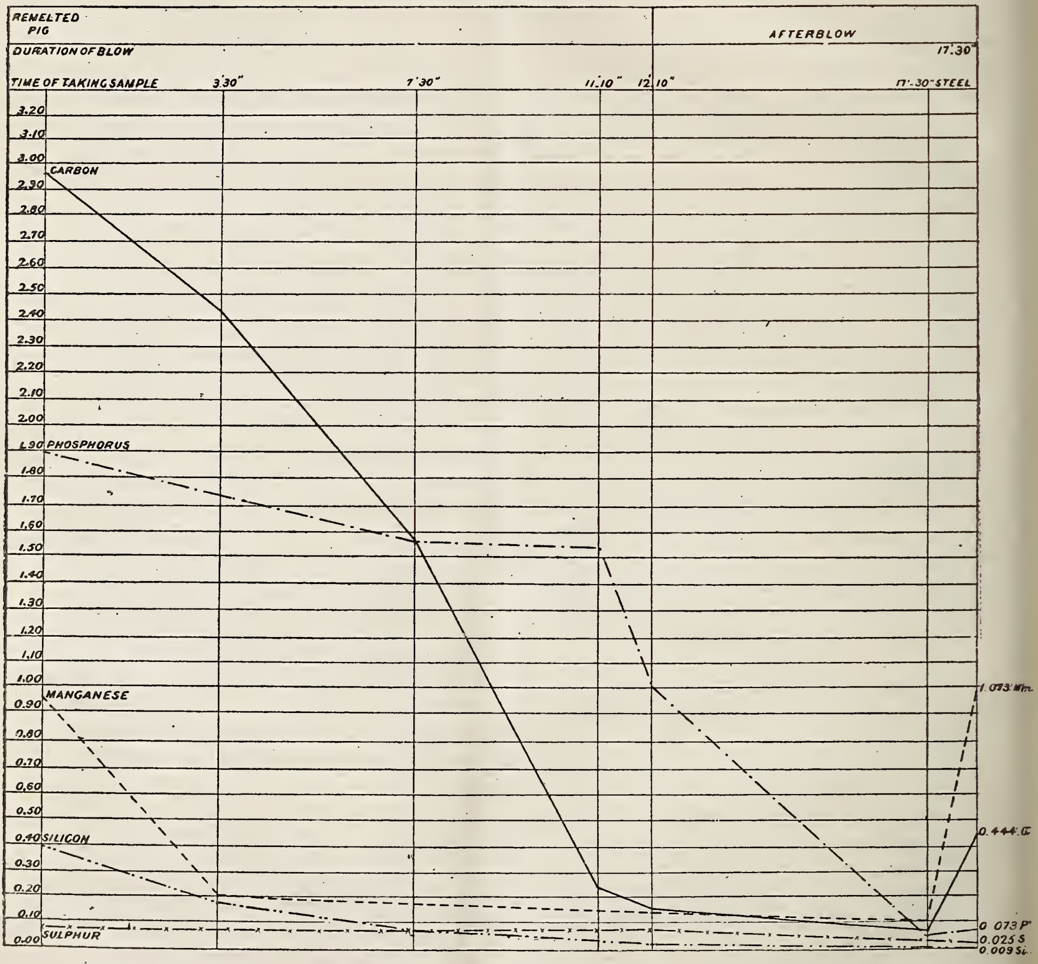


It is obvious that no opinion as to the future of Bessemer dephosphorisation, and the probability of its replacing the puddling process, can be formed, till we know with precision what the cost of converting phosphoric pig-iron into ingot-iron by the Basic-Bessemer process is, as compared with the cost of treating the same iron in a puddling furnace. We may first note that there is an appreciable, though continually diminishing, difference between the cost of converting hæmatite iron and phosphoric iron in the converter. This difference consists of the following items :—

	s.	d.
1st. The cost of the Basic lining is at present from 1s. 3d. to 2s. 6d. a ton more than the ordinary acid lining, say, on an average ..	2	0
2nd. Extra labour on lining, and in dealing with the slag and lime, is nearly 1s. a ton more—say	1	0
3rd. The lime additions per ton of steel	1	10

This, with interest on extra plant (amounting to twopence a ton), and other items, gives 6s. 6d. to 7s. a ton as the extra cost for the dephosphorising process. This, however, is a sum which is continually being diminished, as improvements are introduced. Thus, when hæmatite pig-iron is 16s. a ton dearer than phosphoric iron, the advantage in using the latter is 9s. a ton. In other words, with Cleveland forge iron at 42s., and hæmatite iron at 58s., Basic steel will cost 9s. a ton less than hæmatite steel.

Diagram II., showing the Elimination of Elements in the Basic Converter, by M. Meyer of Luxembourg.



It may be added that, by adopting the late Mr. Holley's ingenious and effective arrangements, by which the shell of the converter can be readily removed, and replaced by a freshly-lined shell, and making certain provisions for dealing with the lime and slag, which entails an extra cost of some £4,000 for a plant having the capacity of those ordinarily used in England, the output in the one process may be made quite as large as in the other. Even without the Holley arrangements, as much as 1,700 tons of steel have been made in a 2-vessel pit, by Mr. Richards, using the rapid "slurry" method of repairing linings.

As compared with puddling, we find that the basic-Bessemer process is more economical in every item except that of loss of metal, the economy in labour and fuel being especially notable. To give some idea of the relative economy of treating pig-iron, such as that for instance, of Staffordshire, Scotland, Lincolnshire, or Cleveland, for the manufacture of weldable iron by puddling, and the basic-Bessemer process respectively, a table has been prepared with some care, in which the puddling costs have been taken in all cases at rather less than the mean figures collected, from a number of works in different parts of England, and checked by costs published on good authority, to which reference is made in the Appendix. The Bessemer costs are derived from the practice of leading firms, working the dephosphorising process, and pig containing at least 1 per cent. of manganese has been taken as typical.

Nothing has been allowed for re-melting in the Bessemer process, the metal being supposed to be taken direct from the blast furnace. Re-melting would add 3s. 6d. to 4s. 6d. a ton to the figures given:—

	Weight in cwt.	Price per ton.	Cost per ton of puddled iron.	Weight in cwt.	Price per ton.	Cost per ton of ingot—iron or soft steel.
		s. d.	s. d.		s. d.	s. d.
Labour	...	...	13 6	...	...	3 6
Coal	22	5 6	6 0½	4½	5 6	1 3
Coke	...	...	...	¾	12 6	0 5¾
Ingot-moulds	...	...	...	...	...	0 10¼
Lime	...	...	...	3⅓	11 0	1 10
Fettling	5	16 8	4 2	...	...	...
Ferromanganese	...	...	...	lbs. 11	300 0	1 6
Refractories	...	...	0 6½	...	...	3 4
Stores and Repairs	...	...	2 0	...	...	2 0
Interest and redemption at 10 per cent.	...	...	1 0	...	...	1 0
General Expenses, Royalty, Yard-charges, &c.	...	...	2 6	...	...	4 6
Total conversion costs.	...	...	29 9	...	...	20 3
Waste	1½	42 0	3 2	3½	...	7 4¼
Total costs, including waste	...	...	32 11	...	...	27 7¼
Pig	...	...	42 0	...	...	42 0
Grand Total	...	...	74 11	...	...	69 7¼

With reference to this table, the following observations may be made. The practice taken as typical is that in which ordinary puddling furnaces are used, probably over 98 per cent. of all the iron made in England being made in such furnaces. There is some difficulty in giving fair average figures for waste and fettling. Thus, probably, the average consumption of fettling is over five cwt., while in some cases as little as 21 cwt. of pig is used per ton of puddled bar. Balancing, however, fettling and yield, it is believed the figures given are rather under than over the average. So with coal, the average consumption is probably over 24 cwts. For best iron, with which the comparison now drawn would, perhaps, be most fairly made, it will be readily understood that the total puddling costs would be nearer 40s. than 33s. Indeed, for ordinary iron, the average costs of puddling would to-day exceed 34s.

There is a very general impression that the cost of Bessemer plant is greater than that of a puddling forge; but, so far from this being the case, the first cost per unit of product is unquestionably less for the Bessemer plant. Thus, a Bessemer converting plant, with the modifications necessary to make it an efficient dephosphorising plant, and equal to a maximum production of 1,000 tons a-week of ingots, can be put up for from £24,000 to £26,000, the capital expenditure, excluding land, being about 10s. per ton of annual output.

In 1872* the Commissioners on the Danks' furnace estimated the cost of a complete puddling plant, to produce 600 tons a-week of puddled bar, at £32,000, and this estimate was generally received as a fair one. Admitting, however, that such a plant could now be built for 30 per cent. less (which is not probable) we should still have puddling plant for 1,000 tons a-week costing £37,000, or some 40 per cent. more than an equivalent Bessemer plant.

For the purposes of the table, we have, however, taken both the puddling and the Bessemer plant as each costing £25,000, for a production of 1,000 tons a week.

That chemical composition is the unfailing index to physical quality, is now an axiom among metallurgists; nor do we find any exception to this rule in the case of dephosphorised steel. The physical properties of this metal are just such as might be predicated from its chemical constitution.

It is not necessary here to recapitulate the evidence by which the immense superiority steel possesses over iron as a constructive material is established. To quote the words of a recent paper by Mr. Ewing Matheson, "Steel has a superiority in strength ranging from one and a-half to twice times that of iron, and at the same time a more than proportionate superiority in ductility and elasticity." That superiority in the case of steel containing about four and a-half tenths per cent. of carbon, was considered by a Committee of the Society of Civil Engineers some years ago, to justify an increase of strain of 50 per cent. being imposed upon it, as compared with that permissive for wrought-iron. Its actual superiority is certainly not represented by the 20 to 25 per cent. increased strain allowed to be placed upon steel by the Government regulations, as this allowance is far from expressing the remarkable resistance presented by steel to percussive strains. Numerous recent cases in which steel-built ships have come out of violent collisions, and running on rocks with nothing worse than dents, show this in a very striking way. So, too, do the experiments undertaken some years ago by the Swedish Iron Board, when it was found that, while plates of ingot-iron would stand from 5 to 9 blows of a weight, falling from a height of 4½ metres, best Staffordshire plates gave way at the first blow of the same weight falling only 1 metre. To the same effect are Adamson's experiments, made by exploding gun-cotton above a series of iron and steel plates, showing that in almost every case the iron plates were broken, while the steel plates were only dished. But, after all, nothing gives better expression to the practical superiority of steel for constructive purposes than the fact that it is, as Mr. Denny has shown, more profitable to build a steel steamer, paying an average price of £8·9 a ton for material, than an iron steamer, of which the average cost of material is only £6·25 per ton. In other words, steel, as a constructive material in shipbuilding, is worth considerably more than one-third more than iron.

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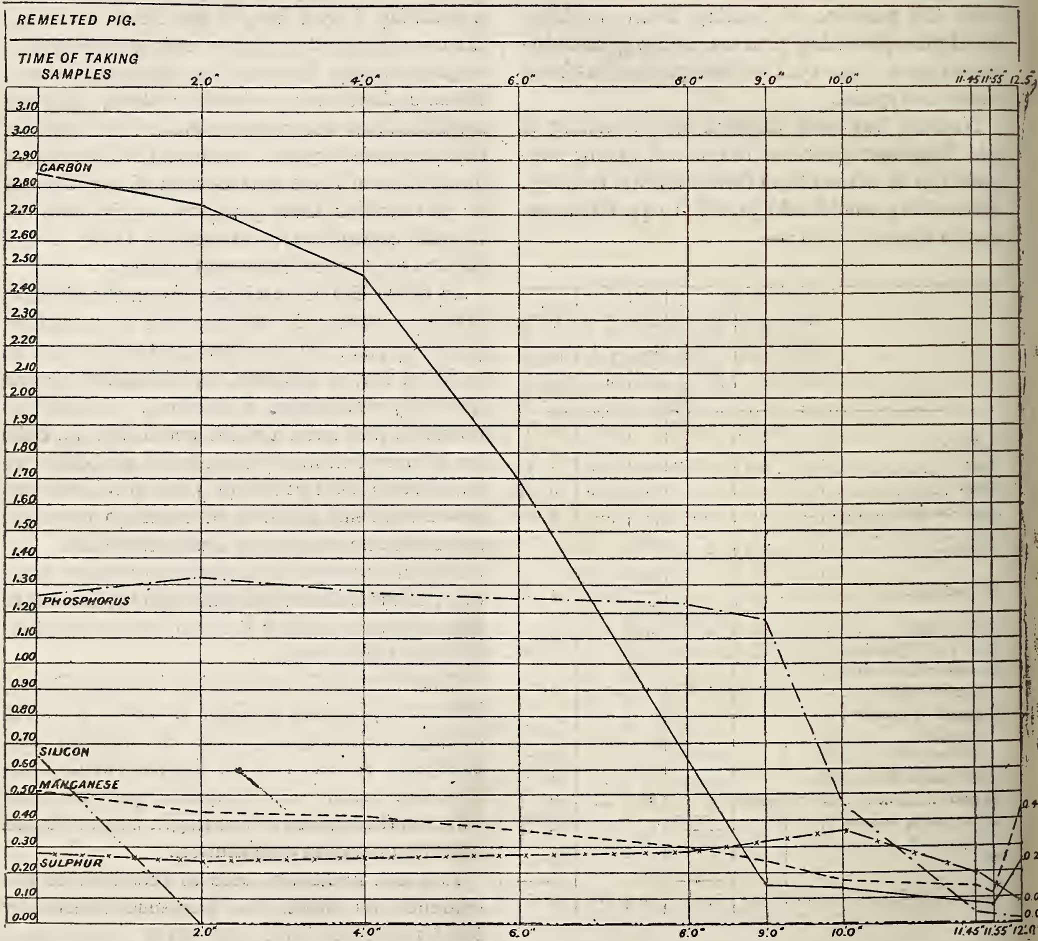
* *Journal Iron and Steel Institute*, 1882.

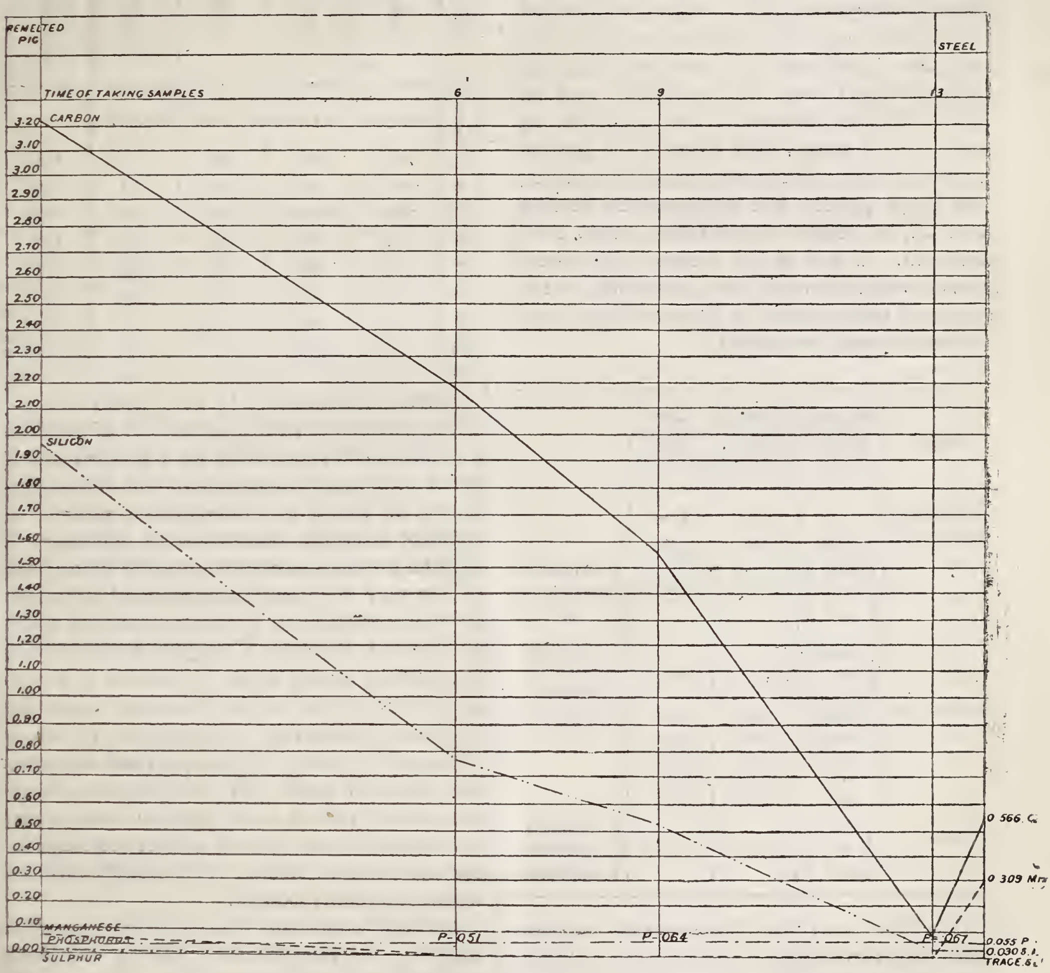
Diagram III., showing the Elimination of Elements in the Basic Converter, from Analyses made at Hoerde Steel Works.



How rapidly steel is growing in favour, notwithstanding its present relatively high price, is shown by the fact that, on the 1st of January last, there were steel ships, building under Lloyd's survey alone, to the extent of 142,000 tons, as against *nil* in 1876.

In considering the peculiarities of ingot-iron as compared with puddled iron, there are some other considerations which may be shortly touched on. In the first place, the loss due to oxidation and expulsion of cinder in reheating and rolling a pile of puddled bar to finished product, is far greater than that attending the same process on an ingot, while the labour cost is also much higher. Thus the average oxidation waste from puddled bar to finished bar or rails, is, on an average, more than three cwts. per ton. The oxidation waste from ingot to steel on the other hand, would be considerably less than one cwt. This saving of two cwts. per ton in oxidation waste, alone represents a money-saving on using ingot-iron of from 7s. to 8s. a ton. The only department of manufacture, in which the older material can be said to have some advantage, is in that of plate rolling. In this industry it is found that the scrap produced, in shearing off the edges of a steel plate to bring it to the required dimensions, is a very serious source of loss, both on account of the large proportion of scrap, and of the fact that this scrap has hitherto been generally treated as fit only for re-conversion into ingots, instead of being used as scrap for welding up for other purposes, as is the practice with the scrap from iron plates. Recent experience, however, shows that steel scrap may, under suitable conditions, be welded with the same facility as iron scrap. Thus, Messrs. Denny,

Diagram IV., showing the Elimination of Elements in the Acid Converter, from an Analysis by Mr. Snetus.



of Dumbarton, made all the forgings for a steamer they have recently constructed from steel scrap. At the Mersey Steel Works large quantities of steel scrap have been employed successfully for large forgings. Other large users of Bessemer steel, have also, for a long time, been in the habit of utilising their steel scrap in this way. At Witkowitz, where their dephosphorised steel is used almost solely for boiler-plates and welded locomotive tubes, the whole of the plate-shearings are piled, welded, and rolled into excellent rivet-iron, sheets, or plates. In fact, the experience of everyone is, that dephosphorised iron is singularly easy to weld. Whether this fact is due simply to its purity, or to some other cause, is at present not ascertained. It is also possible, by rolling very large plates, and subsequently cutting them up, to reduce the shearing scrap to a minimum. A few of the average mechanical tests of dephosphorised steel are given in the subjoined table, which is, however, less complete than could be wished.

Made at	Breaking strain. Tons on sq. in.	Elongation on 8 inches per cent.	Contraction of area per cent.	
Wittkowitz, Austria (1)	22·03	25·0	75·0	
" (2)	23·87	23·5	75·0	
" (3)	28·5 to 31·75	20 to 25	55 to 64	Average medium soft steel.
" (4)	22·86 to 24·76	33 to 37	72 to 77	Average dead soft steel or ingot iron.
Sheffield ...(5)	23·49	28·25	70·01	
" (6)	24·2	26·8	51·7	
" (7)	26·4	29·3	65·5	
" (8)	24·1	26·2	59·0	
" (9)	24·4	31·2	49·0	
Wittkowitz (10)	36·8 to 40·0	20 to 20·5	36 to 51	Average medium hard steel.

It will be seen that these results compare fairly with two samples of special class Yorkshire iron, and Best best boiler-plate examined by Mr. Adamson, which gave :—

Breaking strain. Tons on sq. in.	Elongation on 10 inches per cent.
25·4	18
24·5	15·5

The average tests of thirty Swedish Bessemer plates, tested by the Swedish Iron Board, gave the following results :—

Breaking strain.	Elongation. on 8 inches.	Contraction.
26·28	28·3	52·7

Analysis of above Samples.

No.	Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.
1 2	Analyses	of 1 and	2 given	above.	
3	·19	trace.	·04	·04	·34
4	·06	nil.	·03	.02	·30
5	none	trace.	·07	·03	·24
6	·04	nil.	·06	·03	·35
7	·05	nil.	.04	·05	·24
8	·03	nil.	·06	·03	·26
9	·07	nil.	·09	·02	·37
10	·45	trace.	·06	·04	not given

Having endeavoured to show that there are strong reasons why the manufacture of puddled iron should be superseded by a process which is not only highly economical, but which produces an ingot, or homogeneous product of superior strength, ductility, and elasticity, it may be useful to summarise what is being done in the way of manufacturing, and preparing for the manufacture, of dephosphorised steel. In England, Bolckow, Vaughan, and Company are making weekly about 2,300 tons of Cleveland steel, while on the Continent there are 13 works producing an aggregate of nearly 7,000 tons a-week of dephosphorised Bessemer and Siemen's steel. The total make is, therefore, at the rate of about 450,000 tons a-year. In England there are six converters building for the process, which will probably produce about 3,500 tons a-week.

On the Continent there are 25 converters building for the process, with a minimum capacity of 9,000 tons a-week. Now, as the make of pig-iron in England far exceeds that of the whole Continent of Europe, it is clear that we are, in this matter, allowing our Continental friends to push ahead of us in a way that Englishmen have not hitherto been accustomed to. Which is the wiser course will probably be indicated before very long, when soft dephosphorised ingot-iron, in large quantities, with the advantage of cheapness and superior strength and ductility, will compete, in all neutral markets, with puddled iron. Whether the prediction of Von Tunner—the father of scientific iron manufacture—that the extinction of puddling works is, by the increase of the production of ingot-iron, by the dephosphorising method, imminent, is to be proximately realised or not, we shall soon have an opportunity of knowing. Lest any apprehension should be felt as to the outlet which is to be found for so much ingot-iron, it may be called to mind that we made, last year, nearly 2,700,000 tons of puddled iron, and imported 90,000 tons in addition. The saving in coal alone, had this been made by an ingot process, would have amounted to nearly two million tons, while the smaller waste, in converting ingot-iron to finished iron, would have saved £700,000 worth of material.

No allusion has been made to what may be termed the history of the developments of which it has been attempted to sketch the bearings and influence. If this matter has any interest, it will be better dealt with by others. There is room, however, for a passing regret that this course precludes a tribute being paid to those whose co-operation has brought dephosphorisation to the position it now holds. But, after all, we can all unite in our acknowledgments to those whose genius has rendered dephosphorisation in the manufacture of ingot-metal possible. It should never be forgotten that the attempt to remove phosphorus from a false position is but a minor incident in, and completement to, the great inventions of Bessemer and Siemens.

APPENDIX.

Tensile Tests of Cleveland Basic Steel, made by Bolckow, Vaughan, and Co.

No.	Breaking weight per sq. mm.	Difference between original and fractured area.	Elongation.	Analysis.			
	kilos.	per cent	per cent	C.C.	Si.	S.	P.
1	65·4	36·0	18·0	·36	·05	.06	.06
2	60·3	41·2	22·75	·34	·05	·07	.06
3	65·1	47·3	23·	·39	·05	.06	.06
4	65.1	36·0	18·5	·36	·05	·06	·06
5	63.6	47·3	22·	·34	·05	·05	·06
6	64.2	37·2	18·33	·39	·06	·07	·05
7	65.0	37·2	18·33	·38	·03	·05	·06
8	63.9	37·2	18·33	·37	·04	·05	·06

The above withstood, on an average, 32 kilos. per square mm. without showing permanent elongation.

NOTE.—32·0 kilos. per sq. mm. = 20·32 tons per sq inch.
60·25 ,, ,, = 38·26 ,, ,,
65·0 ,, ,, = 41·27 ,, ,,

Cleveland Steel, rolled into flange rails weighing 40 lbs. per yard, and having a height of 86 mm. ($3\frac{3}{8}$ inches.)

Blow.	Weight of Ball.	Bearing.	Fall.	Analysis.	
	Cwts.		1st blow 15′ deflection in inches.	C C.	P.
630	10	3.′ 0″	$2\frac{1}{4}$	·38	·06
1	,,	,,	$2\frac{3}{4}$	·31	·05
2	,,	,,	$2\frac{1}{4}$	·40	·06
3	,,	,,	2	·40	·07
4	,,	,,	$2\frac{1}{4}$	·39	·07
5	,,	,,	$1\frac{7}{8}$	·40	·05
6	,,	,,	$2\frac{3}{8}$	·39	·04
7	,,	,,	$2\frac{1}{8}$	·33	·06
8	,,	,,	2	·37	·06
9	,,	,,	$2\frac{3}{8}$	·38	·06
640	,,	,,	$2\frac{5}{8}$	·34	·05
641	,,	,,	$2\frac{1}{8}$	·35	·05
642	,,	,,	$2\frac{1}{2}$	·37	·07
643	,,	,,	2	·36	·05
644	,,	,,	$2\frac{7}{8}$	·33	·04
645	,,	,,	$2\frac{3}{4}$	·34	·06
646	,,	,,	2	·35	·06
647	,,	,,	$2\frac{3}{8}$	·36	·07
648	,,	,,	2	.32	·04
649	,,	,,	$2\frac{1}{8}$	·34	·07
650	,,	,,	2	·38	·07
1	,,	,,	$2\frac{1}{4}$	.36	·05
2	,,	,,	$2\frac{1}{2}$	·37	·05
3	,,	,,	$2\frac{1}{4}$	·38	·08
4	,,	,,	$2\frac{3}{8}$	·40	·04
5	,,	,,	$2\frac{1}{4}$	·38	·08
6	,,	,,	$2\frac{7}{8}$	·33	·06
7	,,	,,	$3\frac{1}{8}$	·36	·04
8	,,	,,	$3\frac{1}{8}$	·36	·05
9	,,	,,	2	·35	·05
660	,,	,,	$2\frac{1}{8}$	·33	·06
661	,,	,,	2	·38	·05
2	,,	,,	$2\frac{5}{8}$	·34	·05
3	,,	,,	2	·40	·05
4	,,	,,	$2\frac{7}{8}$	·40	·05
5	,,	,,	$2\frac{3}{8}$	·33	·05
6	,,	,,	$2\frac{7}{8}$	·39	·05
7	,,	,,	$2\frac{1}{8}$	·32	·06
8	,,	,,	$2\frac{5}{8}$	·34	.05
9	,,	,,	$2\frac{3}{8}$	.34	·06
670	,,	,,	$2\frac{1}{8}$	·36	·07
1	,,	,,	2	·34	·05
2	,,	,,	$2\frac{5}{8}$	·34	·06
3	,,	,,	$2\frac{3}{4}$	·33	·07
4	,,	,,	$2\frac{1}{8}$	·31	·07
5	,,	,,	$2\frac{1}{8}$	·37	·06
6	,,	,,	$3\frac{1}{8}$	·30	.04
7	,,	,,	$2\frac{5}{8}$	·32	·04
8	,,	,,	$2\frac{7}{8}$	·32	·04
9	,,	,,	$3\frac{1}{8}$	·30	·06
680	,,	,,	2	·39	·04

NOTE.—The foregoing were all tested in lengths varying from 4" to 6 ft. 6'; but for convenience in comparison, the deflection obtained in the varying lengths has been converted into deflection, or a constant length of 24 ft.

DISCUSSION.

The CHAIRMAN said it was his duty to invite discussion on the extremely interesting and valuable paper to which they had listened. They were favoured with the presence of several distinguished metallurgists, and he would first call on Mr. Windsor Richards.

Mr. WINDSOR RICHARDS was very sorry that he had been the first called upon to discuss the paper, because he found so little in it to discuss. The paper was so lucid, and stated so clearly what had occurred in the dephosphorisation process, that there was nothing left for him to find fault with. When he rose to discuss a paper, he liked to be able to pick it to pieces, in order that differences of opinion might be reconciled, but in the present paper he really found nothing to discuss. He would only say, with reference to the latter part of the paper, that it was too modest. He had been connected with the question of dephosphorisation from its very commencement, and he wished to say, that it was to Mr. Thomas and Mr. Gilchrist, before anyone else, that the invention of the dephosphorisation process was due. He had nothing further to say at present, as he agreed so fully with the paper, but he would like to add a few words if in the course of the discussion the necessity should arise.

Mr. JEANS said it was rather more than three years and a half since Messrs. Thomas and Gilchrist put into his hands, for the consideration of the Council of the Iron and Steel Institute, the original announcement of the discovery which had since then made their names famous wherever iron was fabricated. He thought the progress that had been made in the dephosphorisation process would fairly challenge comparison with that of any industrial process of which there was a record. The Bessemer process had no such successful career in the earlier stages of its development. He believed, if his memory served him right, that Sir Henry Bessemer stated to the Royal Commission appointed to deal with the question of the duration of our coal supplies, that at that time (1869) the total production of Bessemer steel throughout the world was only 150,000 tons a-year. They had heard from Mr. Thomas that the production of basic steel by the process with which his name, and that of Mr. Gilchrist, were so honourably associated, amounted to close upon 500,000 tons, and it was therefore obvious that it must have had a great deal more, on the face of it, to recommend it at once to metallurgists than had the process of Sir Henry Bessemer, although that had effected a far greater revolution in metallurgy than any other process of the present generation. He might mention, that Mr. Windsor Richards was almost the first, if not the first, to recognise the merits of the basic system after the first paper of Messrs. Thomas and Gilchrist had been written, and it was within his certain knowledge that, in the face of a great deal of discouragement, he had persevered until he had made it the magnificent success which it was at the Eston Works at the present day. He would also point out that on the Continent the process had been followed a great deal more than it had in England, because it appeared to be more adapted to their immediate requirements. He had recently made a journey through Germany and Austria, and he found that there was only one opinion there as to the value of the process. The impression of the ironmasters in those countries was, that it would displace the old Bessemer process, just as the old Bessemer process seemed to be displacing the puddling process, which was so well known. On the Continent, up to the present time, the custom had been to produce by the basic process iron adapted for other purposes than that of making rails, but it would seem as if the process was likely to furnish the means of meeting certain specifications with reference to rails, which had recently found a great deal of favour in America amongst railway people, but which it was often troublesome to meet exactly by the Bessemer process. The specification with which the name of Dr. Dudley, the chemist of the Pennsylvania Railway Company, was associated, stipulated for about 0·40 per cent. of silicon. By the Basic Bessemer process that might easily be met; but by the old Bessemer process it was not quite so easy. He hoped that the somewhat absurd specifications that had been suggested in connection with the Pennsylvania and other American railways, were not likely to be generally adopted in this country; but if it should happen that we took from them our chemistry, as we had done a great many other things of recent years, the Basic process seemed to be the only means by which those specifications could be uniformly met. It was now some years since Mr. Barlow, past President of the Institution of Civil Engineers, ventured upon the prediction, that steel would ultimately supersede puddled iron for all purposes except those of the blacksmith's forge. That prediction had not yet been fulfilled, as last year we manufactured 2,700,000 tons of puddled bar, which, according to statements appearing in the reports of the Coal Commissioners, and estimates made by other competent authorities, was somewhat in excess of the average of the last sixteen years. In other words, the consumption of puddled bar in this country at the present time, was perhaps as great as ever it had been. Whether Mr. Thomas, in the face of that fact, would retain his belief that puddled iron would cease to be used, he could not say, but at any rate, the facts were against him at the present time, although perhaps it might be "so much the worse for the facts." The paper was one to which he had listened with very great interest, and he was sure when it appeared in the *Journal* of the Society it would well repay careful perusal.

Dr. Sandberg could only say that, as a Swede, he was very sorry to hear that the days of Swedish iron had gone by. He thought the paper gave so much detail that there was hardly any room for discussion. He had had the pleasure on the previous day of visiting the Eston Works, and he saw the process at work on a large scale, when everything was satisfactory. He considered that the testing of steel by means of the fractures was quite sufficient to indicate, to a practised eye, whether phosphorus was present or not, and he only wished there was an equally good criterion for silicon. He agreed with Mr. Jeans as to Dr. Dudley's specification, that it was quite absurd to limit the silicon to such a low amount; it would neither ensure solidity nor clean rolling. He did not agree with him, however, that it could not be done with the ordinary Bessemer process, because his experience was that it was done in this country. Of course it was quite true that in the Basic process there was hardly any silicon; but in the ordinary Bessemer steel there was about the same as Dr. Dudley wished, which he thought was too low, and they had only to go to the Continent to see that there could be a great deal more, and yet give good results. They could be very liberal as to the chemical composition, so long as the mechanical tests were satisfactory, and to be limited to one specification as to the proportion of the chemical constituents would unnecessarily augment the price. Chemistry has done excellent service in the past, and would do excellent service in the future, but it must not be overdone. He had the opportunity of seeing, at the Eston Works, the phosphorus tested in one hour sufficiently near for practical purposes, which for the maker was a great advantage. He could only say that, as far as his experience went, he had had no better results, both mechanical and chemical, than from the Basic process; and upon what he saw at Eston, he congratulated Mr. Richards.

Professor Huntington said he had never listened to a paper which more clearly set forth the pith of the subject than the one they had just heard, besides giving all the necessary details. Mr. Windsor Richards had claimed great credit for Messrs. Thomas and Gilchrist, and everybody would agree that he had rightly done so. He had spoken of unnecessary modesty, but he appeared to be suffering from the same complaint. To his knowledge, Mr. Windsor Richards had worked like a slave at the subject, and the success of the process was, to a great degree, due to his untiring energy. Of course all these things must stand the test of time, and one must not hope for too rapid progress. To the manufacturer it was a matter of pounds, shillings, and pence, and a man could not be expected to pull down his plant, and erect new, without some deliberation; but, in his opinion, in the course of time that process would certainly replace the puddling process all the world over. The puddling process was a brutalising process, and was no credit to anybody. That it should have held its ground so long was a marvel, and was no doubt due to the slow progress which metallurgy had made until recent years. He thought they might look upon the basic process as the outcome of the introduction of science into the iron manufacture. He should like to call attention to the fact that recently in France the authorities had decreed that ingot-iron or soft steel should not be used for boilers, which he thought was a step altogether in the wrong direction. There was no idea in England of imitating that example. The process introduced to them that night was capable of turning out a class of steel than which nothing could be better for boilers and ship plates, and he thought the French authorities would have to rescind what they had done. By the energy of Messrs. Thomas and Gilchrist, the difficulty of producing steel from phosphoric iron ore had been overcome; but even this process would not give satisfactory results with ores containing a large amount of sulphur, and therefore that remained to be dealt with by some energetic individual.

Mr. Riley said the paper to which they had listened, stated facts which were rather within than beyond the mark. As to the question of iron containing sulphur, he must say that it did not present much difficulty to him, as the introduction of a little manganese was all that was necessary. Sulphur was a thing that could be dealt with in the blast urnace, but one could not very well deal with phosphorus. There was only one establishment in England using the Thomas and Gilchrist process, but it belonged to a very large firm. In England there was a somewhat bountiful supply of iron ores free from phosphorus, whereas, on the Continent, most of the ores were phosphoric, and, therefore, it was much more to the benefit of the Continental works to adopt this process than to the English; hence the reason why it was more used there. He mentioned that, to explain why it was that the process had been adopted so much more extensively on the Continent than in England. All those who were acquainted with the puddling system, knew that it was a barbarous one, and it would be a great boon to supersede it, as in hot weather it was no uncommon thing to see a puddler drop down dead. One of the best Bessemer managers said the other day that the ordinary Bessemer process had been worked up to such a pitch that there was no chance of reducing the cost, but he thought in the Basic process shillings in the ton might be saved by improvement in the details. He quite agreed with what Dr. Sandberg had said about Dr. Dudley. Practical experience had shown that Dr. Dudley's conclusions were fallacious. He also agreed with Dr. Sandberg, that the proportion of silicon might go up very nearly to a half per cent. In Germany it was frequently so, and sometimes in England.

Mr. Richard Smith said there was not much in the careful, able, and well-written paper to discuss, but he thought Messrs. Thomas and Gilchrist had been too modest. With iron ores containing a large amount of phosphoric acid there was a splendid field open for the new process, but where the ores did not contain phosphorus, it was too expensive to displace the others. He thought there was a great deal of prejudice to be overcome in this country on the matter, but on the Continent the men carried their practical education and their scientific education together to a greater extent than they do in England.

Mr. BARKWORTH wished to know whether the 2,300 tons a week of Cleveland steel, referred to in the paper, were wholly and solely from Cleveland ore, or from a mixture of Cleveland with Lancashire or Spanish ore, and if so, in what proportion?

Professor HUNTINGTON said Mr. Riley had spoken rather lightly of the presence of sulphur. It was all very well to say you could get it out: so you could, but at present it entailed considerable additional expense.

Mr. RILEY said many iron masters were obliged to use ores containing sulphur, and some works were obliged to use coke containing a large amount of sulphur. He would not enter into the practical question of how this was dealt with, but it was dealt with, and he was not at all afraid of it.

Mr. BARKWORTH said he would like to hear something about the preparation of the bricks used in the process.

The CHAIRMAN said he thought all who were treating phosphoric ores with basic linings, were very much in the position of the able American metallurgist, the late Mr. Holley, who said that, as an American ironmaster, interested in American metallurgy, he viewed with resignation the attitude of those who had not adopted the process. With regard to silicon, it appeared to be the case that in the basic process, although its oxidation takes place very rapidly at first, it is not evolved until the bulk of the carbon and manganese had disappeared. One point of special interest in the paper related to the purity of the product obtained, and another point was the saving in the oxidation waste with regard to the ingot-iron. The paper had not touched upon the history of the process, but, without for amoment ignoring the work of Berthier or of Gruner, he might state that it was the outcome of the teaching of Dr. Percy, whose students had brought the basic process to a successful issue. In conclusion, he proposed a vote of thanks to the authors for their very admirable paper.

Mr. WINDSOR RICHARDS said that the quantity of ingot-iron made per week from the converters now at work was 2,550 tons, and he believed it would soon be 3,000 tons a week. When the Thomas and Gilchrist process was brought before the Iron and Steel Institute, he had the honour of exhibiting a diagram, showing the way in which the phosphorus was eliminated. Reference had been made to Dr. Dudley's composition for the manufacture of steel rails, and he might mention that he was in America last September, and spent several days with Dr. Dudley. In a long conversation with him he thought he had convinced him that his recipe for the manufacture of steel for rails was a quack recipe. Professor Huntington had spoken about ores containing sulphur, which was a subject worth careful consideration. In America there was a mine called the Cornwall mine, yielding an ore containing four per cent. of sulphur, He did not agree with Mr. Riley's method of eliminating sulphur in the blast furnace by means of manganese, as it was expensive, but he thought it could be best eliminated by careful calcination. A question had been asked, whether Lancashire ore was mixed with the Cleveland ore, and in reply, he might say, that there was not an atom of Lancashire, or any other ore mixed with it. It was found that 1½ per cent. of phosphorus in the pig-iron was not enough to give a warm blow in the converter, as they tried to make the pig-iron as low in silicon as possible, because it fluxed the lining. There was no such thing in the Cleveland Works as re-melting pig-iron—it was all taken direct from the blast furnaces. Another gentleman asked as to the manufacture of the bricks for the process. They took magnesian limestone, burnt at a white heat; till it became a substance more like flint than anything else. That was mixed with tar, and ground into a very strong paste. [Mr. Richards then explained by means of sketch on the black-board, how the lining was put in without using bricks.] They could put the lining in, and get to work, in twelve hours. Where the greatest wear and tear of the vessel was, there was the greatest thickness of lining. He had not the slightest hesitation in saying that they would make as much steel, if not more, at the Eston Works, by the basic process, as they had done by the acid process.

Mr. MARTELL remarked that the reason steel was not more extensively used for ships was that shipowners were not yet satisfied with reference to the general character and reliability of steel which, was liable to crack in a way that could not be explained. He should like to know whether, by this process, they might look forward to a greater certainty in this respect. If the apprehensions of shipowners with regard to the cracking of steel could only be allayed, he felt persuaded it would lead, more than anything else, to the general introduction of steel in place of iron.

Mr. GILCHRIST said they had not found hitherto any difficulty in keeping the sulphur down to 3-10ths in the pig. At the same time, he agreed that a method which would eliminate 99 per cent. of sulphur would be an important discovery. They had always looked upon Bessemer's discovery as a double one; it was a chemical discovery, and it was also a mechanical one; instead of obtaining the product by manual labour as in the puddling process, it was obtained by machinery. Naturally such an important invention as that took a very long time before all the mechanical details could be perfected, and they had been fortunate enough to step forward when all these mechanical details had been mastered and a school of Bessemer engineers had been trained up, thoroughly able to deal with all the mechanical difficulties, and the progress which had been made was chiefly due to to the co-operation they had received from those eminent mechanical engineers.

Mr. THOMAS said he thought perhaps too much credit had been given to them for what they had done. Other men had laboured, and they had entered into their labours. If anyone was entitled to speak with authority on the subject of dephosporisation, it was Mr. Windsor Richards. They had now a process in regular and extensive operation which could produce with regularity and more cheaply than puddled iron, a product which, on the admission of the Board of Trade, was 25 per cent. better than iron, and there could therefore be no doubt as to the ultimate result. With reference to what had been said about steel cracking, they all knew that steel was a new material, and that iron was an old one. All surveying bodies and inspectors were, therefore, far more careful with steel than with iron. If all the faulty plates of iron were labelled and pointed out, as was the case with steel, the comparison would be enormously against iron. If there was a faulty steel plate, a diagram was at once made, and a paper read, and everybody knew all about it; but there was no such brilliant light thrown upon the defects of iron. In conclusion, he might say that all tests showed the superiority of ingot-iron over puddled iron.

TWENTIETH ORDINARY MEETING.

Wednesday, May 3rd, 1882; W. H. PREECE, F.R.S., member of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Carter, George, Manchester and Salford Bank, Southport.

Everitt, William E., Finstall, Bromsgrove, near Birmingham.

Gamble, Lieut.-Colonel David, Windlehurst, St. Helens, Lancashire.

Howell, Samuel Earnshaw, Brook Steel Works, Sheffield.

Kershaw, John, Memb. Inst. C.E., 1, Arlington-street, Piccadilly, S.W.

Little, George, Werneth-lodge, Oldham.

Lloyd, Charles, 167, Howard-place, Shelton, Stoke-on-Trent.

Lloyd, Francis Henry, Wood-green, Wednesbury.

Penny, Colonel, R.E., Bineleaves, Weymouth, and East India United Service Club, S.W.

Scott, William, Memb. Inst. C.E., 1, Southwick-crescent, Hyde-park, W.

Teetgen, William, Lea-view, Mount Pleasant-lane, Upper Clapton, E.

The following candidates were balloted for and duly elected members of the Society:—

Agelasto, John Michael, 22, Pembridge-crescent, Bayswater, W.

Gillespie, Rev. Charles George Knox, A.K.C., 20, Dawson-street, Manchester.

Gotto, Edward, Memb. Inst. C.E., The Logs, Hampstead, N.W., and 17B, Great George-street, S.W.

Greenwood, Arthur, Albion Works, Leeds.

Grenfell, Henry Riversdale, Bank of England, E.C., and 15, St. James's-place, S.W.

Gurdon, William Brampton, Queen Anne's-mansions, S.W., and Treasury, S.W.

Harris, Henry William, Park-lodge, Eltham, Kent.

Hodgson, Charles, Signal Works, Kilburn, N.W.

Kennedy, Thomas Stuart, Meanwood, Leeds.

Laing, Arthur, Thornhill, Sunderland.

McKay, John, care of Messrs. R. and W. Hawthorn, St. Peter's, Newcastle-on-Tyne.

Parfitt, Edward Browne, 24, Maxilla-gardens, Notting-hill, W.

Philipson, John, 9, Victoria-square, New-castle-upon-Tyne.

Price, Henry Sherley, Woodbury-lodge, Wickham-park-road, St. John's, S.E.

Reid, Ernest J., 16, Coleman-street, E.C.

Shervinton, Thomas Robert, 32, Arundel-gardens, Notting-hill, W.

Shilton, Alfred J., 40, Paradise-street, Birmingham.

Slater, Charles, F.C.S., 46, Clarendon-rd., Notting-hill, W.

Spencer, Eli, The Hollies, Werneth, Oldham.

Stanhope, Hon. Dudley H. E., Harrington-house, Charing-cross, S.W.

Tildesley, David, 6, Devonshire-villas, Brondesbury, N.W.

Veley, Victor H., B.A., F.C.S., University College, Oxford.

Wilson, James, M.A., F.C.S., 2, Essex-court, Temple, E.C.

The paper read was—

THE FIRE RISKS INCIDENTAL TO ELECTRIC LIGHTING.

BY THOMAS BOLAS, F.C.S.

When we violently disturb the molecules of any body, that substance ordinarily becomes hot. Here, for example, are two flints, and when they are struck together, so much heat is produced as to raise some of the minute particles which are separated to a visible red heat. If it were practicable to perform this experiment in an absolute vacuum, the result would be the same—red-hot particles of flint would be struck off. Here, then, we have a good example of the production of a moderately high temperature by the mechanical disturbance of the molecules of a solid body, and you may call this mechanical disturbance either friction or percussion—two expressions which run into each other, or mean very nearly the same thing. Now, be kind enough to notice carefully the effect of replacing one of the flints by a piece of hard steel, in order that you may compare these two cases. Mr. Barker will operate with the flints alone, while the flint and steel are being stuck together by myself. You notice that scintillating sparks of a totally different character result; the fact being, that particles of both flint and steel are struck off and heated to a bright red heat by the impact, but the particles of steel take fire and burn. That is to say, they unite with the oxygen of the air, and heat is evolved by the union of the iron and the oxygen. You will remember, that whenever two bodies unite chemically to form a fresh substance, that heat results, and when this heat attains a certain degree of intensity the phenomenon called fire results.

Practically, only three sources of heat are open to us. 1. Solar heat. 2. Heat arising from physical shock, or molecular disturbance, which disturbance may arise by the collision of masses, friction, or the contention of matter with an overpowering electric current, or other physical agency. 3. Chemical union, either direct or differential.

In reference to the subject before you to-night, the first source of heat may be disregarded, although it is, as it were, the ancestral spring of most of the heat which is available hereabouts; but the generation of heat by chemical union, and by physical disturbance, must be observed in order to render it possible to appreciate the conditions under which electric agency may cause combustion or burning to set in.

To begin with, let me call your attention to some simple and typical instances of combustion. Here is some charcoal, and you know well that the combustion of charcoal consists in its direct union with the colourless invisible gas called oxygen. Notice what happens, then. When the charcoal is immersed in the bottle filled with oxygen gas, nothing happens; things remain as before. To cause combustion or burning to set in, a tolerably high initial temperature is required, and when the combustion has once commenced, it will continue until either the oxygen or the charcoal is all consumed. Now for one other instance. Hydrogen gas is issuing from this jet, and as it escapes, it finds itself in contact with the free oxygen of the air, but no combustion or combination occurs until the action has been started by a temperature approximating to a red heat. You see how the iron wire, made red hot, lights the jet of hydrogen, and the jet will continue to burn, until some discontinuity occurs as regards the supply of either the hydrogen or the oxygen.

The temperature at which the violent chemical union called combustion sets in is termed the igniting point, and it varies according to the nature of the combustible body. Many substances, as, for example, zinc ethyl, and a certain impure variety of phosphuretted hydrogen, ignite spontaneously on exposure to the air at ordinary temperatures, that is to say, the igniting point is lower then the usual temperature of the atmosphere.

Here is a glass jar containing water, into which a few fragments of phosphide of calcium will be dropped. The impure variety of phosphuretted hydrogen is immediately evolved, and rises in bubbles through the water. It cannot inflame until it reaches the surface, or until it comes in contact with the free oxygen of the air, but as the bubbles break at the surface, they take fire.

In other cases, a higher temperature is necessary to cause inflammation; as in the case of a piece of phosphorus, which, as you see, inflames at a temperature below that of boiling water, as contact with this iron rod, which has just been warmed by immersion in hot water, inflames it at once.

Many examples of intermediate igniting points could be given, besides bisulphide of carbon, which, as you see, is ignited by a rod heated to a temperature just below redness; hydrogen, which requires a red heat, and coal-gas, which will not ignite until exposed to a temperature approaching a white heat.

Notwithstanding the above remarks, the combustibility of a substance depends, to a great extent, on its state of division. An ordinary lump of lead is not what one would call a combustible substance in the ordinary sense, yet very finely divided lead will take fire immediately it is exposed to the air. Here is a sealed glass tube containing such finely divided lead; you see that, as soon as the tube is opened, and the fine lead is poured out, that it takes fire, or unites energetically with the oxygen of the air The same thing happens in the case of iron, and several other metals, when in a finely divided state. In order to fairly illustrate the reason why finely divided metals take fire spontaneously, it will be necessary to study other examples of spontaneous combustion.

Here is some cotton-waste, with which has been incorporated a little linseed oil; and if this were left undisturbed for a few days, it would certainly take fire, and burn energetically. This is because a slow oxidation, or low burning, commences at once, and the heat evolved by this, gradually raises the temperature of the mass to the kindling point of the mass of oily cotton. A more striking example of the same kind of action will now be placed before you. A solution of phosphorus in bisulphide of carbon, is poured over some pieces of cotton-waste placed in this dish, and as the carbon disulphide is a very volatile liquid, it flies away almost immediately, and leaves the fibres of cotton covered over with a thin layer of finely-divided phosphorus. This phosphorus at once commences to unite slowly with the oxygen of the air; a moderate amount of warmth being caused, but without producing combustion in the ordinary sense of the term. The fact of the phosphorus being spread in a thin layer over an enormous surface, so far increases the extent to which the slow union takes place, that the accumulated warmth soon becomes sufficient to cause rapid combustion to set in. The same thing occurs in the case of the lead or the iron, the surface being so increased that the heat produced by the surface oxidation accumulates sufficiently to cause inflammation to set in. This is much the same kind of action which causes spontaneous inflammation of hay ricks, or of fibrous matters which may have been stored away in a damp or oily condition.

Let me call your attention to another case of slow oxidation, which may suddenly burst out into vigorous or ordinary combustion. Here is some platinised asbestos; that is to say, asbestos which has been covered over with a thin film of the metal platinum. A jet of ordinary coal gas is allowed to play against it, and a slow union of the coal gas with the oxygen of the air immediately takes place on the surface of the asbestos, bringing it to a low red heat. This heat gradually increases, until it attains sufficient energy to actually ignite the gas.

When the electric current freely circulates through a conductor sufficiently large to allow it to pass easily, little or no heat is produced, but if we interpose in its path a moderately bad conductor, that conductor becomes heated as a consequence. The most intense calorific effects result when thin strips of a fairly good conductor are interposed in the circuit, as when an enormous resistance is offered to the passage of the current, it becomes practically blocked, and but little or no effect is produced, as when the terminal wires of a battery are joined by a bar of ebonite or of glass.

In order that you may take note of the heating effects of the current, these battery terminals will be joined by thin strips or wire of various metals, and you will notice how they are instantly heated, burned, and deflagrated.

Here is a kind of lattice or gridiron, built up out of thin iron wires, and placed in the circuit of a battery, consisting of 60 Bunsen cells. At the present time, the wires are only just warm, for, taken together, they do not offer enough resistance to become intensely heated. These wires will now be successively cut by a pair of scissors, so that the wires are placed out of circuit one at a time, and at each cut-out the remaining wire becomes hotter, so that fusion or deflagration of the last five takes place.

To illustrate this matter further, let me remind you that silver is the king of conductors among metals, while the pretender, German silver, offers about 14 times as much resistance to the passage of the electric current. Here is a kind of chain, built up of alternate links of silver and German silver, and you will notice that when the current is passed through the chain, the German silver links become heated to redness, while the genuine silver shows no signs of heating.

When a powerful current is cross circuited, or short circuited, by a thin metallic wire, it often happens that this becomes intensely heated, and many dangerous accidents have happened this way, as is the case of Mr Christophie, who had his watch-chain melted, and waistcoat set on fire, by incautiously leaning against some light leads in the Paris Electrical Exhibition.

Let me demonstrate to you the effect of short circuiting with various moderately good, or moderately bad conductors. You see that a thin iron or German silver wire is melted instantly; while a thin gold watch-chain is volatilised immediately, and a piece of gold lace is immediately transformed into a charred mass; while a mixture of gunpowder and bronze powder is immediately ignited. A piece of the gold paper-bordering such as is used for decorating rooms is also ignited, and you thus see how dangerous accidents may arise from unprotected light leads.

The various electric fuses which are used or exploding mines and torpedoes, depend on the heating power of the current when it traverses a bad conductor. There are several examples of these in the room; some interesting specimens, together with magneto-electric appliances for igniting them.

It is quite within the limits of possibility for a gilt moulding, or beading, to become ignited, should the metallic surface short circuit a current, and it may interest you to see that a blacklead pencil mark may conduct sufficient electricity to set the paper on fire; and I have known a case in which a thin piece of ebonite was set on fire through having had some chloride of gold solution spilled on it, the metal having become reduced by the action of light.

When a powerful current is passed through a thin strip of carbon, the carbon becomes intensely heated, and if exposed to the air it naturally burns at once, as you see now. When, however, the carbon strip is enclosed in an exhausted vessel, the case is altered; it merely glows with an extremely bright light. And if all is satisfactory, it will stand this kind of treatment for a prolonged time, say from one to three thousand hours. Here we have incandescent lamps by Swan and others, in which a carbon thread is enclosed in a glass bulb, and as these form the safest kind of electric lamp, they will require special consideration at a later stage of the proceedings.

The heat produced by interposing a thin strip of a moderately-good conductor in the circuit, is made available for other purposes than firing torpedoes and incandescent lamps; very convenient and portable gas-lighters being made with a thin strip or wire of platinum, which can be heated to whiteness by a single cell of a bichromate battery contained in the apparatus. You see how convenient this arrangement is in actual use, and as it is easy to prolong the conductors to any extent, such an apparatus may prove very useful in lighting gas in inaccessible positions. Other forms of incandescent lighters are on the table, and you can examine them when the proceedings have terminated.

Not only can the electric current produce heat, but it may also produce cold, as will next be illustrated to you. Here is a compound bar, consisting of a rod of antimony, soldered to a similar rod of bismuth, the whole being included in the bulb of an air thermometer, excepting the unconnected ends of the bars which project outside the bulb. When a current is passed from the bismuth bar to the antimony bar, cold is produced at the junction, as you may see, by the rising of the column of coloured spirit, while the reversal of the current causes heat to be produced.

When a current of enormously high potential suddenly overcomes the resistance of a very bad conductor, what is called a disruptive discharge takes place, the bad conductor being perforated or broken by the discharge. In the case of the ordinary electric spark in air, the air is broken, and the result is a snapping sound, as the result of the disturbance. Here is the Holtz machine in an improved form, as sold by Messrs. Becker & Co., of Maiden-lane; and you see what torrents of disruptive discharges result when the handle is turned. You also see how easily these sparks will ignite coal-gas or alcohol, the very smallest spark serving for this purpose. This is well illustrated by the small inductive gas-lighter now before you, in which a small electrophorus is so mounted that it can be conveniently used as a portable gas-lighter. A further illustration is afforded by the circumstance that the minute disruptive spark obtained from one of the small magneto-electric machines, sold in the toy shops for 12s. 6d., will instantly ignite coal-gas or other vaporous combustible. You see how immediately the gas is lighted. In order to set fire to a solid body by the disruptive discharge, we either require one of enormous force, or a series following each other in rapid succession, as, before a solid body can inflame, it generally requires to be, more or less completely converted into vapour by the action of heat; or to otherwise receive a notable increment of heat through a considerable portion of its mass. Notice the effect of passing a disruptive discharge among gunpowder; it is merely thrown about, but not ignited; while if the discharge is retarded, by placing a piece of wet string in the circuit, the case is different, the powder is ignited. Now let us take the case of a rapid succession of disruptive discharges on gutta-percha. You see that the covering of this wire is very soon set on fire at the point where the covering is discontinuous, and a thin sheet of gutta-percha takes fire almost immediately.

A most remarkable discovery has recently been made by Mr. G. Stillingfleet Johnson, of King's College, who finds that the silent effluve, which serves to partially ozonise oxygen in the Siemens' ozone tube, will cause the explosive union of oxygen and hydrogen. In this case, you must understand that no conductor comes in contact with the explosive mixture, these being separated by a considerable thickness of glass, and that the action is purely inductive. Mr. Johnson has been kind enough to make arrangements to demonstrate his important and interesting discovery before you, this being the first public demonstration which has been given. It appears to me that further study will show that Mr. Johnson's discovery has an important bearing on the subject of this evening's discourse.

The arc light, in which the current is passed from one carbon pencil to another—these being then slightly separated—is complex in its nature, as we have three actions at work. In the first place, we have something approximating in its nature to a disruptive discharge, as the carbons may be removed to a considerable distance without breaking the circuit; in the next place, there can be little doubt that the partly formed vapour, or nebulosity of carbon, conducts after the fashion of an incandescent lamp, while ordinary combustion of the carbon takes place simultaneously. These three circumstances together tend to make the arc light that form of the electric light involving most risk of fire, and consequently, requiring the most careful precautions; while the circumstance that it is necessary to work an arc light with a current of higher potential than is required for incandescent lighting, also tends to throw the risk in the direction of arc lights.

One of the most serious dangers incidental to the arc light, arises from the falling of pieces of hot carbon; but by using carbon of good quality, and taking reasonable precautions as regards catching the pieces, the danger is reduced to a minimum. Notice how unsteadily and dangerously the light burns when pieces of porous and spongy gas carbon are used, sparks flying and pieces falling off: but when good carbons are used, this kind of thing very seldom occurs. It is a great advantage for the carbons to be either plated with metal, or enamelled, and there are excellent specimens of plated and enamelled carbons on the table, which are exhibited by various manufacturing firms. It sometimes happens that irregularities in the action of the dynamo-machines will cause pieces to fly off the carbons, or that the presence of foreign bodies imbedded in the pencil, will determine a fracture. No arc lamp should be used without a satisfactory arrangement for catching any pieces which may fall off, and before you are the arrangements made by the Brush Company for preventing mischief from a breaking up of the carbon pencils.

Here we have asbestos trays, or spark catchers, as manufactured by the United Asbestos Company; these being placed under the lower opening of the globe.

The incandescent system of lighting is by far safer than the arc method; and, considering that this latter system is likely to come into general use for house illumination, it is gratifying to be able to take this view of the case. In fact, there is every reason to believe that when proper precautions are taken, the incandescent system will prove considerably safer than gas for general purposes. You know that a large number of Swan's lamps are in action at the Savoy theatre, no less than 824 being employed in lighting the stage alone; and it is impossible for anyone inspecting the thoughtfully arranged appliances not to at once appreciate the greater safety of the incandescent lighting over gas under such circumstances. It may be mentioned that all the machinery is in a distinct building. It appears to me that a greater security might be attained in theatres if the gas were entirely dispensed with, and a broad guide band, painted with the phophorescent paint, were employed as a reserve source of light in case of anything going wrong with the electric machinery. In connection with this subject, may be mentioned a suggestion made by Professor Barrett as regards a similar point. He considers that when the incandescent system is installed in a house, there will be less occasion for lucifer matches, and that if the switch handles are enamelled with the phosphorescent material, it will be easy to find the switch in the dark and turn on the current. Such a tap will now be handed round.

The first to call attention to the notable fire risks which may result from a careless installation of the electric light, was Mr. W. H. Preece, your chairman to-night, who wrote a long letter to the *Times* in the autumn of 1880, pointing out some of the principal sources of possible danger. Since then, the subject has received a considerable amount of attention, and the insurance companies have been accused of acting harshly as regards the fire risk question. In the case of the Crystal Palace, an extra premium, at the rate of no less than 42s. per cent. per annum, has been demanded; but, of course, this covers numerous risks which cannot fairly be laid on the back of electric lighting, and in estimating the risk, dangers incidental to gas or steam machinery should be estimated separately, as in many cases the electricity would be sent from a distant station.

Carefully considered rules for ensuring safety as regards electric lighting, have been drawn up by Professor Morton, the Edison Corporation, Mr. Musgrave Heaphy, Mr. W. A. Anderson, Mr. E. W. Carpenter, and others, but experience has shown that in many cases under-estimates have been made as to the extent of precaution necessary, especially as regards the diameter of leads and their thorough insulation from metal work.

It was my intention to lay before you a set of rules for the prevention of fire, elaborated by myself, but just before the proceedings commenced this evening, Mr. Heaphy handed me a copy of the second edition of his rules, as drawn up by him at the instigation of the Phœnix Fire Office, and as they embody most of the new points which it was my intention to bring before you, it will be better to make Mr. Heaphy's rules a basis, and then discuss a few points in detail.

MR. HEAPHY'S RULES.

Requirements.

1st. All rods or wires in a building to be so placed as to be thoroughly and easily inspected.

2nd. All rods and wires to have sufficient sectional area, so as to allow at least 50 per cent. more electricity being safely sent through them than will ever possibly be required for the lights they supply.

3rd. All main rods (or wires) should be thoroughly well insulated with a material rendered as non-inflammable as possible, and further protected by coverings of a substantial and durable character. Wherever practicable the rod (or wires) should be enclosed in iron, brass, lead, terra-cotta, or earthenware pipes, the space between the rod (or wires) and the pipe being completely filled with a high insulating compound. Or the rods (or wires) should be thoroughly well insulated with a material, as non-inflammable as possible, and might be placed in slate beading, or slate boxes. To be approved by the inspector from the fire office.

4th. The wires for "arc lights" to be insulated and protected in the same manner as the aforesaid main rods or wires. The wires, unless enclosed in pipes, or slate boxes, &c., as described under requirements No. 3, should be laid at least 8 inches from each other, and 8 inches from all other wires, metal, or conducting substances. Or where this, from the nature of the case, is impossible, then the wires must be kept at least one inch apart, and one inch from all conducting substances by a continuous rigid non-conducting material, to be approved by the inspector from the fire office.

5th. The wires for the incandescent lights should be at least 2½ inches from each other, and 2½ inches at least from all other wires, metal, or other conducting substances; they must be thoroughly well insulated with a material rendered as non-inflammable as possible, and protected by coverings of a substantial and durable character; and where external injury is possible, they should be insulated and enclosed in iron, lead, brass, terra-cotta, or earthenware pipes, or in slate beading or slate boxes, in the manner described under requirements No. 3 for the main rods.

(In non-hazardous risks the wires, having been thoroughly well insulated with a material rendered as non-inflammable as possible, should, where practicable, be enclosed in wood beading, and the wires kept apart by a continuous fillet of wood at least one inch wide.)

6th. All rods or wires passing through floors or partitions must be insulated, and enclosed in iron, brass, terra-cotta, or earthenware pipes, or slate beading, in the manner described under requirements No. 3.

7th. All rods or wires passing through exterior walls of buildings must be insulated and enclosed in pipes, as described under requirements No. 3; and the insulating material must be impervious to moisture.

8th. All rods or wires in a building that are exposed to moisture must have a waterproof covering to their insulating material.

9th. The fastenings of all rods or wires to be composed of an approved non-conducting material.

10th. Any material employed for conducting the electricity, in lieu of rods or wires, must be protected in the same manner as the before-mentioned rods or wires.

11th. All lamps, switches, or any bare connections, must be so mounted, that leakage of electricity from them is rendered impossible.

12th. When two wires are joined together, the junction must be soldered, or secured by a thoroughly clean binding screw, or clamp.

13th. Wherever a branch wire is led off the main conductor, to supply current for one or more incandescent lamps, a short length of lead, or other fusible wire, must be inserted between the main conductor and one end of the branch; and the lead wire must be of such section and nature, that if the current passing through it exceeds the normal current by 50 per cent., then it will fuse and disconnect the branch.

14th. No naked lights allowed. If "arc lights" are used, the globes must be enclosed at the base, and have chimneys so arranged that no sparks or flame can escape. The globes must also be covered round with wire netting.

15th. All "connections," "cut-outs," or "resistance coils" must be placed in such a secure manner that no danger can arise in the event of their heating.

16th. A shut-off must be placed at the point of entrance to each building.

17th. No ground circuit allowed.

18th. All work is to be of a substantial character, and put up in a thorough workmanlike manner, and to be accurately tested at the time of erection for insulation.

19th. When the "electric light" is intended to be used, information must be supplied of the particular system of lighting that is to be adopted; how and where the electricity is to be generated; the number and kind of lamps used; the quantity of electricity to be conveyed through the wires; the conductive capacity of the wires; method of insulation; whether there is to be metallic circuit; and, as far as possible, full details of the manner in which it is proposed to equip the building.

MUSGRAVE HEAPHY, C.E.

Phœnix Fire-office,
February, 1882.

April, 1882.

As regards modifications I would suggest the following:—

1. When the electricity is supplied to a building from a distant station, an effective cut-off shall be provided within two feet of the point where each conductor enters or leaves the premises. Such cut-offs to be, when practicable, sufficiently accessible from the public way on the outside of the premises, and to be quickly reached by a man provided with such tools as would serve for breaking open an ordinary door. Each cut-off is to be marked so distinctly as to show at a glance in which direction the handle must be turned for breaking or making the circuit.

2. When the electricity is generated on the premises, a similar cut-off accessible from the apartment where the electricity is generated must be provided for each wire or branch entering or leaving the appartment.

3. Each conductor or lead placed inside a building, if of copper, must possess a sectional area equal to four times the sectional area of the thickest wire, or parallel combination of wires, which exists in the dynamo or magneto machines used. If iron is used as a conductor, it must be tinned or galvanised, and its sectional area must not be less than six times as great as if it were copper.

4. No conductor to be allowed to come nearer than one-fourth of an inch to any other metallic body whatever, excepting when these form essential parts of lamps commutators, resistance coils, or similar apparatus; and no wire is to be allowed to come within half-an-inch of any metallic body having direct electrical connection with the earth. Metal tubes should not be used as casings for leads passing through partitions, &c.

5. All connections of conductory wires, branch wires, and rods must not only be thoroughly soldered, but also bound. In the case of iron rods (tinned or galvanised) a short tubular socket, also tinned or galvanised, should slip over the united ends before the solder is applied.

6. Wherever the conductor passes through a wall or partition, it shall take as direct a line through as practicable, and the hole through which it passes must be bushed or lined with a non-porous earthenware or glass tube, with sides not less than one-eighth of an inch thick; this tube to form one unbroken length through the partition. After the conductor is in its place, the space between it and the tube may be packed with any suitable non-conducting substance.

7. When a conductor is fitted inside a building, the most careful precautions must be taken to protect it from rain drift or other water, either by the use of slate grooving of suitable sections, or by other means. When a wire passes through an external wall, the outer end should turn downwards, and be so covered by a cap of earthenware or slate, that no water can enter the insulating tube; the tube should also incline slightly downwards, towards the outside of the building.

8. No underground conductor is to be enclosed in a metal tube, but combustible bodies, such as gutta-percha, asphalt, paraffin, or the like, may be used in the insulation of underground conductors.

9. In the case of wires fixed above ground, the coating of the wire must be of a non-combustible character, or, at any rate, of such a nature that fire will not run along the wire should the coating become ignited. When the lead is laid in close contact with wood, or other similarly inflammable material, the immediate coating of the wire must be of an absolutely uninflammable material, such as asbestos; but in this case, especial care must be taken to protect the wires from becoming accidentally wetted.

Mr. Heaphy has very properly kept in view the fact that an insurance office must not, especially during experimental developments, be over rigid in its requirements, as many points will, undoubtedly, require careful consideration by both insurance companies and lighting associations.

Although when suitable precautions are taken, there can be no doubt that the dangers incident to electric lighting are no greater than those incident to gas lighting, and, in many cases, are considerably less; but one point in favour of electricity is, that it is only calculated to effect ignition, and not feed the flames like a gas-pipe laid open by fusion; and this consideration may bear on the fact that many alarms of fires of electric origin have been given, but only a few actually destructive conflagrations are recorded. Almost every fire of electric origin has been the result of the grossest carelessness, and the neglect of precautions which ought to suggest themselves to any one.

Messrs. Crompton and Co. have communicated to me their views in the following words :—

"As to conductors, we prefer to use for heavy cables, copper strand, insulated with ozokerited rubber, for all cases where there is danger of damp, but for indoor purposes we use cables with a copper strand core, tinned and insulated with vulcanised rubber. We have given up the use of cables insulated with tarred tape, as we had dangerous short circuits from their use, the action apparently being as follows:—At any point where there was any slight drop on the cable an action of an electrolyte nature appeared to take place, and the tar covering heated, and eventually charred, as if it were carbonised by fire, with the result of a short circuit and dangerous contact. Since we have used the cable insulated with ozokerited rubber we have had no contact whatever from this cause. For coal mines, where the danger from a contact would be most disastrous, we have used cables heavily insulated with gutta-percha, and find they are perfectly safe.

"Turning now to the branch conductors used for incandescent lamps, which are the principle source of danger, we have generally arranged our circuits for board-ship work so that no one conductor could have more than thirty amperes passing along it, and we have made all our branch conductors of No. 16 B.W.G. copper wire, heavily insulated with ozokerited rubber, and arranged in the twin form, that is, the insulation of each wire made perfectly complete and then cemented side by side, although at first sight, this placing the two wires in juxtaposition may seem courting danger, the reverse is really the case. The principle cause of a short circuit in the branch lead is the crossing of the wires when concealed behind wainscoting or any other ornamental covering; in the act of screwing this down, if the wires by any mischance happen to get across one another, the cores are liable to be squeezed into contact. With the twin wires above described this is impossible to take place, as the two wires must lay true and parallel to one another. Through No. 16 wire we pass 30 amperes of current for a considerable time without dangerous heating, so that even if a short circuit did take place in a branch, and the lead cut-out did fail to act, still it would be improbable that a fire would take place. The lead cut-outs we employ consist of one inch of 20 lead wire always attached to the branch wire; one of its wires joins the main, so that a short circuit on the branch to the lead cut-out is impossible. In the case of chandeliers (or as we call them lustres), we put a second set of lead cut-outs at the place where the main couples are forked into the various branches, so as to give additional security.

"*Danger from Arc Lamps.*—We avoid the danger from the dropping of hot fragments of carbon in a twofold manner. We place round the base of the lower carbon itself a small mica cup, and, in addition, we fix a closed ash-pan some small distance below the same to avoid the danger, when many lamps are burned in series, that if several lamps happen to be cut out of circuit, the arcs in the remaining lamps become inordinately long, and the flame from them dangerous. Each lamp should be provided with an equivalent resistance attached to the cut-out itself, consisting of four coils of galvanised wire. The cooling surface of this wire is so great that when the lamp is cut out, and the whole current is passed through these alternative resistances, it does not heat up to a serious extent, in fact, never beyond 150 degrees; furthermore, as in our system we never employ more than 400 volts of E.M.F., and if all the arcs were thrown into one lamp, the length of it would not be excessive, certainly not sufficient to give a fire risk."

Numerous gentlemen and firms have assisted me by the loan of specimens, and by their personal aid. Mr. G. F. Williams has kindly lent his dynamo-machine, and has kept constant watch over the electric lamp which is burning towards my right. The United Asbestos Company have lent as fine a selection of asbestos manufactures as one could wish to see. We have not only wires and leads coated with an absolutely incombustible coating, but also compressed blocks and asbestos felts; while their fireproof tubes for leads, as used by the Edison Company, will speak for themselves. Thread, cloth, and gloves, made of asbestos, are of considerable interest; these latter being useful to electric-light workmen; but it appears to me that the triumph of their manufacture is the thin and compact asbestos paper, which contains, they tell me, no less than 95 per cent. of asbestos. Messrs. Swan and Edison have lent me many of their lamps, and appliances used in their working; and, to illustrate the general safety of incandescent lamps, Mr. Barker will proceed to break several of these Swan's lamps which are in action, against this muslin curtain, there being not the least danger of inflammation. The safety-catch arrangements of Edison, Swan, and Siemens, are before you; these arrangements, consisting of a short piece of lead wire, so placed in the circuit that any undue force of current resulting from short circuiting will melt it at once. Mr. Swan's miners' safety lamp is now in action, and has proved of great value in actual practice, while Messrs. Faraday and Son have sent many of their special appliances, as used in the application of the Swan system, among which you will notice Severn tunnel lamps, Channel tunnel lamps, and their theatre fittings, as used at the Savoy; their combined switch and safety catch is a very neat article, which you will perhaps pass round.

An ingenious safety arrangement which is employed by the Brush Company deserves special notice. This resistance box, as it is termed, contains a large electro-magnet, which you see here, and when the main current which passes through it is increased by a short circuit at any point, this magnet is brought into increased activity, and, by means of these levers, a set of carbon plates is compressed together, these plates being connected by a shunt circuit with the field magnet wire of the dynamo; and, as the compression reduces the resistance of the set of plates, the field magnet becomes more or less completely short circuited, the main current being thus brought down to the proper intensity. This apparatus is perfectly automatic. There is no danger of it becoming unduly heated, and it is much more satisfactory than the usual cut-outs, or equivalent resistance coils.

Mr. Patterson's dark room lamp for photographic use, is a piece of apparatus likely to be useful, and to diminish the risk of fire in the dark room, there being, of course, no danger of inflaming the ether contained in the photographic collodion. This idea of making the Swan lamp serve for dark room use, was suggested in the *Photographic News*, and Mr. Paterson has well carried it out. The very complete series of leads, both ordinary and fireproof, shown by Phillips Brothers, will interest you, especially these new incombustible leads, which only blacken when heated, as you now see, the fire not extending beyond the portion held in the gas burner.

The very complete and satisfactory manner in which Messrs. Siemens' differential lamp is enclosed, so as to prevent risk of fire, will be obvious to you if you examine yonder specimen; and before you go, just glance at a series of ingeniously-designed clamps, for attaching branch wires to a circuit, these being exhibited by Messrs. Faraday and Son.

DISCUSSION,

The CHAIRMAN said they were all deeply indebted to Mr. Bolas for bringing forward this subject, and for having illustrated it in such a profuse manner. The paper was on the fire risks incidental to electric lighting, but he had also given numerous examples of the risk of fire in our daily occupation. He (the Chairman) had been on the brink of a burning volcano, and had stood on the deck of a burning ship, but in neither of those instances did he feel he was incurring such a risk from his fellow-creatures as he did in sitting on that platform. On the one side, he had a powerful battery throwing out most offensive fumes, in front of him was a miniature cannon, in the shape of a Bunsen burner emitting flames, every now and then he heard suppressed cries, caused by burnt fingers, and saw what looked like flashes of lightning flying about here and there. If he were not an electrician, he should certainly jump to the conclusion that Mr. Bolas had thoroughly carried out his intention of showing what were the risks of electric lighting; but from what he knew of him, he was inclined to believe that his object was totally different, viz., to prove that, although the employment of electricity for domestic purposes was accompanied by a certain amount of danger, yet it might be rendered perfectly safe, if they took advantage of the teachings of experience, and the knowledge which had been obtained. For nearly thirty years he had been playing with electricity, and knew what it could do. He had seen even those slight currents which were used for telegraphic purposes set fire to premises, and produce accidents, and he had also seen the terrific damage caused by the vagaries of the tremendous store of natural electricity which was found in the atmosphere. Now, electric lighting in houses and streets could never attain such terrific force as these currents of electricity which were termed flashes of lightning; but notwithstanding the terrible power which lightning possessed, it could be rendered as harmless as a little child, when you knew how to do it; and the secret of safely lighting houses and streets by electricity, like the secret of making houses safe from lightning, lay simply in the knowledge of how to do it. Mr. Bolas had told them a great deal, but possibly some present would like to put some further questions, and as it was too late to enter on a regular discussion, he would ask speakers to confine themselves to putting questions on the subject immediately before them.

Mr. LIGGINS said he had been startled by the statement, that a bundle of cotton-waste would certainly ignite in a week if it were saturated with linseed oil, and he should like to ask if the same effect would be produced by the use of sperm oil. It was once his misfortune to lose several friends in the *Amazon*, which was burned in the Bay of Biscay, and though the cause of that fire was never clearly traced, there was reason to fear that it occurred through the spontaneous combustion of cotton-waste, which had been placed in a dangerous position.

Mr. DONOVAN asked whether two sets of rules had been laid down by insurance companies for electric lighting, one set for incandescent lights worked by machines with low resistance, and another set for the arc light worked by dynamo machines with high resistance?

Mr. MUSGRAVE HEAPHY said he should have been happy to say something on this subject, but it was now engaging the attention both of the fire offices and electric light companies; and, therefore, anything he might say would probably be taken as an official opinion by the Phœnix Fire Office, with which he was connected. If the rules had been read out, the last speaker would have found part of his question answered, but those rules were for hazardous risks, not for ordinary risks. In drawing out these rules, the Phœnix Office had never lost sight of safety, from the insurance point of view; but, on the other hand, anything of an irritating or unnecessarily harsh character, with regard to the lighting companies, had been carefully avoided.

Lord OTHO FITZGERALD said the Faure Company were very kindly lighting his house in the country gratuitously as an experiment, and he should like to know whether it would be at all likely to interfere with his fire insurance policy.

Mr. HEAPHY said these rules had not been drawn up by the fire offices generally, but simply by the Phœnix Company. They did not wish to bind any other office to their requirements.

Mr. BOLAS said that the only point on which he was invited to remark was the risk involved in the use of a secondary battery and incandescent lamps. This method he had already alluded to as the safest possible form of electric lighting. If lamps working with a current of low potential were employed, and ordinary precautions taken with regard to the insulation of the wires, it was difficult to see how any danger could arise. The risks would be certainly less than with gas.

The CHAIRMAN, in moving a vote of thanks to Mr. Bolas, said there were some dangers connected with electric lighting, but he believed it could be made safer than any other means of artificial illumination. There had been several accidents arising from electric lighting, houses had been set on fire, and persons had been killed, and especially in New York and Boston some of the conflagrations had been very great, but he had examined, with a great deal of care, all the cases of which he could get the particulars, to find out how it was that electricity had behaved so badly, and in every case he found it was owing to the grossest possible ignorance on the part of those who laid the wires, or fixed up the lights. It could not be too strongly urged that the whole danger was due, not to the electricity, but to the want of experience in the workmen. Electricity was most tractable; if it could be led across the Atlantic without danger or difficulty, surely it could be led about our houses without danger. The fact was, that electric lighting made such rapid progress, that in some cases a sufficient number of experienced workmen had not been available, and inexperienced men being employed, danger and accident resulted. Though great attention was paid to this matter by the insurance offices, both in America and England, he did not think they had done all they ought to have done. It was very commendable on the part of Mr. Heaphy to produce such a report as the one alluded to in the paper, which he had read with a good deal of pleasure, and endorsed all the rules proposed; but considering the number of highly experienced and skilled electricians which England possessed —men who had encompassed the whole of the globe with submarine cables, who had been the promoters of the application of electricity to useful purposes everywhere, he should have thought the fire insurance companies might have called together some of these men, and got them to draw up a set of rules, which could have been published, not only with the authority of the insurance offices, but with such names as Varley, Clark, Sir William Thomson, Fleeming Jenkin, and a few others attached to them. He did not think it was too late even now to do such a thing. The public were acquiring excessive confidence in electric lighting; new companies were continually coming forward, and the way in which money was being put down for them was very striking. When people were so ready to rush into these investments, he thought it was only right that the timid householder should have his fears entirely removed, by a report issued on unimpeachable authority. He was inclined to think this was one of the things which might be inaugurated by the Society of Arts; a committee might be formed, or something might be done by which such rules as had been drawn up by Mr. Heaphy, complete as they were, should be stamped with the authority of the leading electricians.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

MANUFACTURE OF CHEESE IN ITALY.

For many years the Italians have been celebrated for the excellence of their butter and cheese; of the latter very many descriptions are made. In Piedmont, large quantities of "gruyera," "fontina," "rubiole," "grana," and "stracchino," are made, and these, according to Consul Crain, of Milan, are considered the best of the Piedmontese manufacture. "Gruyera" and "fontina" are made from the Estival pasturage of the Valley d'Aosta. "Rubiole" are small sheeps' milk cheeses of Alba, Mondovi, and Acqui, whence they are exported in considerable quantities. "Grana" and "stracchino" are Hovarese products.

The former is made during ten months of the year, the latter in October and November. A large quantity of excellent butter, "grana," and "strachino" is made in Southern Lombardy and Mortara. Lecco, Varese, Bergamo, and Breschia, produce good "stracchino" and butter, and delicious cheeses, called "formaggini," are made on the rich pasture of the Valtellina hills. The following is a description of the process employed in the manufacture of the various Italian cheeses. "Stracchino" of Gorgonzola is made of milk containing the buttery parts. When the mountain pasturage is exhausted, the Bergamese herdsmen drive, for wintering, their herds to the plains. Gorgonzola is their favourite halting-place, as it is there they first find the luxurious vegetation of the Lombardian plateau. The herds, feeding on the rich grasses of Gorgonzola from the middle of September to the end of October, give plentiful supplies of milk. Cheese is made during these months in small rooms devoted to it, in the homes of the Gorgonzolese, who buy the milk of the herdsmen. The autumn temperature, being moderate, is best for cheese-making, as too much heat, by hastening the separation of the whey, makes it too dry and friable, while excessive cold produces an acid taste. The milk while warm from the cow is curdled with well preserved and prepared calf rennet. In fifteen or twenty minutes, when the milk is coagulated, and the whey separated, the curd is hung in hemp bags to drain; the curd, when drained, is then enclosed in light flexible wooden bands, covered on their inside surface with hemp cloth, and placed on an inclined plane strewn with rye chaff. The curd is further drained during the first day of the process by two or three turnings, and on the cloth being removed, its value is determined by weighing. After three or four days, fermentation commences, and the wooden bands are removed. It is then, once daily for eight or ten days, alternately salted on its upper and lower side, four ounces of pulverised salt being on an average used for every 33 lbs. The Gorgonzolese adopted, some years ago, the process of quickly turning and pressing the cheese against a salt covered surface, thus ensuring more uniformity and a better crust. The colour changes in a month to pinkish white if good, to black if bad, as in this case the crust is soft and the cheese is apt to deteriorate in summer. It is calculated that about one hundred quarts of milk make about twenty-five pounds of cheese. "Bellunese" cheese is made by heating the milk, pouring in the rennet, letting it coagulate, breaking it into medium sized pieces, re-heating, putting in wooden tubs, salting and placing on stands for daily turning, and re-salting until consumed. The following process is employed in making a kind of Frinlani cheese, known as "fieno." Milk is heated until tepid in cauldrons, then mixed with rennet and left to curdle. The curd is broken in vessels into small pieces, and violently shaken over the fire. When thus crumbled, the cauldron being set on a stand, it is gathered, thrown into the "talcio" or forming tub, placed on tables for drainage, dried, and finally steeped in brine. In making "formaggio di grana," milk is poured into cauldrons and placed on the fire; if mature, that is of a bluish tint, it is warmed to the twenty-fifth degree, if sound, or retaining its whiteness and the sweet taste of freshly milked, it is heated to the thirtieth degree, then mixed with rennet. One-sixth of an ounce of rennet is used for 720 quarts of milk. The rennet is dissolved with a pestle in wooden cups, filtered through horse-hair sieves, the oozing going into the cauldron of milk. To prevent hardness, the curd formed is broken and turned with the cream turner, "rotilla" (a stick with a wooden disc at the end), and the "spino" or cane with twisted twigs or iron pins at one extremity, and this is continued for the space of three quarters of an hour. Turning is occasionally stopped to consolidate the now softened or dissolved curd. The whey is removed, and one sixth of an ounce of saffron to every 110 quarts of milk, is thrown into the cauldron, the curd is replaced and left for an hour on the fire, heated to the forty-fifth degree, and continually stirred with the "rotilla." A cup is filled with curd for examination as to the minuteness of its particles; if small enough, the cauldron is removed, and the curd sinks and forms at the bottom. To hasten this, the cooled whey, before being drained off to allow of the addition of saffron, is poured into the cauldron, the bottom of which is pressed with the "rotilla" to unite the curd. The curd is then loosened with a stick from the sides, drawn on the surface, collected in a cloth, placed in a vat, and left there for an hour, and then moistened with whey. It is then marked with the name of the owner, pressed by hand in a box of narrow beech boards, bound with hoops and pack thread, and covered with linen, a wooden disc and a heavy stone. When dried, these coverings are removed, and it is moistened again with whey, and then covered with buckram. After some hours this buckram is cut, and the whey permitted to soak in. It is covered, and rubbed on an oak bench with salt, dipped in salt water, and again pressed between the beech boards; it is re-salted every day for a fortnight and placed in the cheese house, where superfluous salt is removed by scraping. In September it is rubbed with cheap oil. The cows of the numerous dairies of Puglia and Basilicata are milked once daily. The milk, when poured into large vats, and half heated to a point which will make it and the unheated, mixed—when tested by the hand—30° Réaumur. Whey of goats' milk is mixed and shaken in it, and when curdling it is covered with a cloth to keep up the temperature. When curdled, it is broken, stirred with the "rotolo" till it is in filbert shaped pieces, placed with whey in a vat, beaten again, wetted, and covered with warm whey. When ductility is obtained by heating on hot coals or boiling in water, the curd is called "crescinta" or grown. It is then cut, the pieces thrown into the pail, where they are soaked in hot water, reunited, manipulated, pulled into thread, and made into as many balls as there are cheeses to be made. These thread balls are immersed in water, manipulated till perfectly compact, formed into proper shapes, and daily salted for two or three days. Cheese thus made is called "Caciocavallo de Puglia." "Proratura" cheese is made of cows' milk, which is poured into large pine tubs, dissolved kid rennet is added, and the mixture turned with the "rotolo." Upon coagulation the curd is not allowed to get lumpy, but is pressed and softened with the "rotolo." When the curd sinks in the vat, a sieve of pierced tin is placed and held over it by weights. If much whey rises, it is used for "ricotta;" if little, the sieve is removed, and it is left to facilitate growth. When ductile, it is cut into small pieces, poured into another pine vat, and previously prepared hot water poured upon it, and here the curd is kept till cooked, when the water is drawn off. It is then in portions, gathered and stirred with a wooden spoon, and formed by hand, previously moistened with cold water, into two-pound balls, which are placed in tubs of cold water, and there left for two hours, and finally salted.

DANGEROUS PROPERTIES OF DUSTS.

Professor Abel, F.R.S., delivered a lecture at the Royal Institution on Friday evening, April 28, on "Some of the Dangerous Properties of Dusts," of which a short abstract is here given:—The liability to the development of fire or of heat sufficient to char or inflame portions of flour by the stoppage of the feed of grain, appears from all accounts to be extremely difficult to guard against, and to have been the cause of many serious calamities even since the Tradeston explosion, examples of which are the great explosion of six mills at Minnesota in 1878, when eighteen lives were lost and much property was destroyed; and the fatal and destructive explosion of a flour mill at Macclesfield in September last, which has been made the subject of a Report to the Home Office by Mr. Richards of the Board of Trade. It appears to be the opinion of experienced men in the trade that, although special attention to the feed arrangements may reduce the number of explosions, this cause of accident is almost impossible to guard against; while on the other hand, many fires or explosions ascribed to it, have been due to the employment of naked lights in mills near localities where the air is laden with flour-dust. Considering that flour and rice mill owners have to bear the burden of very heavy rates of insurance, it is to their interest, independently of their responsibilities as the guardians of the lives of their workmen, to adopt most stringent regulations and efficient precautionary measures for abolishing this source of danger, and to devote their energies to the application of improved arrangements for reducing the quantity of dust which passes away from the millstones, and from other parts of a flour mill.

The important part played by coal-dust, which exists in greater or less abundance in all coal-mines, in aggravating and extending the injurious effects of fire-damp explosions, was originally pointed out early in 1845 by Faraday and Lyell, when they reported to the Home Secretary the result of their inquiry into an explosion which occurred at Haswell Collieries in September, 1844.

Ten years after the publication of Faraday and Lyell's Report, M. de Souich, an eminent French mining engineer, published as original, some very similar observations made by him on examining the effects of a coal-mine explosion at Firminy; he noticed, moreover, that men near the pit's mouth had received burns, while others who were in the workings near the seat of the explosion, but out of the main air current escaped unhurt, and he ascribed this to the action of coal-dust in carrying flame along the principal air-way. Later on, de Souich extended his inquiries into the part played by coal-dust in explosions, and the subject was afterwards pursued, from time to time, in France, by Verpilleux and other authorities in mining engineering, and especially by M. Vital, in 1875, when an explosion occurred at Campagnac, the destructive effects of which appeared to him in a great measure ascribable to coal-dust. Vital made experiments upon a very small scale, for the purpose of ascertaining whether flame, such as that projected into the air of a mine, by the firing of a charge of powder, in a very strong blast-hole, was increased in size by the presence of suspended coal-dust; and soon afterwards Mr. W. Galloway commenced a series of experiments of similar nature, but upon a larger scale, which he has continued from time to time up to the present date; while Messrs. Marreco and Morison, in connection with the North of England Institute of Mining Engineers, and a Committee of the Chesterfield and Derby Institute of Engineers, have also contributed valuable experimental data bearing upon the influence exerted by coal-dust, not merely in increasing the magnitude of explosions resulting from the ignition of mixtures of fire-damp and air, but also in propagating or even actually developing explosions, when only small quantities of fire-damp are present in the air of a mine, or where fire-damp is believed to be entirely absent. The conclusion to which Mr. Galloway was led by his earlier experiments was to the effect that coal-dust, when thickly suspended in air, had not the power to originate an explosion, or to carry on to any distance the flame from a blown-out shot, but that the presence in the air of such small quantities of fire-damp (2 per cent. and under) as an experienced miner would fail to dectect by means of his Davy lamp, with which the gas is generally searched for, would impart to a mixture of coal-dust and air the property of burning and carying flame. But he held the view at the same time, that a fire-damp explosion in one part of a mine might be propagated to some extent by coal-dust raised by the effects of the explosion in parts of the mine where no fire-damp existed. Marreco, on the other hand, considered that the results of certain experiments made in the entire absence of coal-dust, by firing shots in air travelling at some considerable velocity, and containing coal-dust thickly suspended in it, warranted the conclusion that coal-dust also might, under certain conditions, originate an explosion as well as carry it on to some considerable extent. The results obtained by the corresponding experiments of the Chesterfield Committee appear to support this view, and Mr. Galloway has also, by his later experimental results, been led to the same conclusion, and considers that the results of his examination into the effects produced by some of the most serious of recent coal-mine explosions (at Penygraig, Risca, and Seaham) demonstrate that those explosions were chiefly, if not entirely, attributable to coal-dust.

The strong impression entertained by many, during the inquiry into the great explosion at Seaham Collieries, in September, 1880, that coal-dust might have had much to do with the accident, and that the explosion was possibly even entirely due to the ignition of coal-dust by a blown-out shot, in the absence of any fire-damp, led to Mr. Abel being requested by the Home Secretary to make experiments with samples of dust collected in the mine, and to an extension of these experiments to dust collected from collieries in different parts of the kingdom where explosions had occurred.

The results of experiments conducted with great care and on an extensive scale at a colliery in Lancashire, where a constant supply of fire-damp was brought to the pit's mouth from a so-called blower, confirmed the fact demonstrated by M. Vital and Mr. Galloway, that the propagation of fire by coal-dust, when thickly suspended in air, is established or greatly promoted by the existence, in the air, of a proportion of fire-damp, which may be so small as to escape detection by the means ordinarily employed (such for example as exists in the return-air of a well-ventilated mine).

It was also established that a mixture of fire-damp and air approaching in proportions those required to be explosive, would be ignited by a flame if only a small proportion of dust were floating in it. Further, it was demonstrated that, although those dusts which were richest in inflammable matter, and most finely divided, were the most prone to inflame and to carry flame, in the presence of small quantities of fire-damp, some dusts which contain coal only in comparatively small proportions were as sensitive as others much richer in inflammable matter, and that even perfectly non-combustible dusts possessed the property of establishing the ignition of air and gas mixtures which, in the absence of dust, were not ignited by a naked flame. The action of non-combustible dusts appeared to be due to physical peculiarities of the finely divided matter, and to be perhaps analogous to the contact-action so well known to be possessed by platinum and some other bodies, whereby these bring about the rapid oxidation of gases which, in their absence, may exist intact in admixture with oxygen or air.

Although it may be very doubtful whether coal-dust, in the complete absence of fire-damp, can be credited with the production of extensive explosions, as has been recently maintained by some, there can be no question that, in the presence of only very small quantities of fire-damp, it may establish and propagate violent explosions; and that, in the case of a fire-damp explosion, the dust not only, in most instances, greatly aggravates the burning action, and increases the amount of after-damp, but that it may also, by being raised and swept along by the blast of an explosion, carry the fire into workings where no fire-damp exists, and thus add considerably to the magnitude of the disaster. The supposition that extensive coal-mine explosions may be produced by coal-dust alone, in the complete absence of gas, necessitates the fulfilment of conditions which cannot be at any rate very exceptional, but its acceptance is unnecessary to add to the formidable character of coal-dust as an agent of destruction in mines. The possibility of dealing with the dangerous dust in mines should, therefore, be as much an object of earnest work as has been the improvement of ventilating arrangements in mines.

The actual removal of dust-accumulations being in most instances impracticable, the laying of the dust by an efficient system of watering the mine ways, is a matter deserving serious attention. Although in some instances such a measure is not readily applicable without injury to the workings, it has been already proved in some districts to be unobjectionable and susceptible of very beneficial application. The employment of deliquescent substances (calcium chloride, sea-salt, &c.) in conjunction with watering has also been advocated and tried to some extent with success.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

MAY 10.—"The Fish Supply of London." By SPENCER WALPOLE, late H.M. Inspector of Fisheries. EDWARD BIRKBECK, M.P., will preside.

MAY 17.—"The Constant Supply and Waste of Water." By GEORGE F. DEACON. Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, will preside.

MAY 24.—English and Foreign Technical Education Contrasted and Reviewed from a Professional Standpoint. By E. C. ROBINS, F.S.A.

FOREIGN AND COLONIAL SECTION.

Tuesday Evening, at Eight o'clock :—

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

Thursday Evening, at Eight o'clock :—

May 25. — "Recent Passages of Zulu-Kafir History." By Robert James Mann, M.D., F.R.C.S., F.R.G.S. The paper will be illustrated by means of the lime-light lanthorn.

Applied Chemistry and Physics Section.

Thursday Evenings, at Eight o'clock :—

May 11.—"The Recovery of Sulphur from Alkali Waste. Schaffner's process. A record of recent results." By Alexander M. Chance, of Birmingham.

Indian Section.

Friday Evenings, at Eight o'clock :—

May 5.—"Experiences of an European Zemindar (landholder) in Behar." By James Mylne.

May 26.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. Royle.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Fourth Course will be on "Book Illustration: Old and New." By J. Comyns Carr.

Lecture 1, May 8.—The proper relation of printed text and illustrated design. History of the art. Early wood engraving.

Lecture 2, May 15.—Various modes of book illustration. Modern development of wood engraving.

Lecture 3, May 22. — Modern processes of illustration. Influence of photography upon the art.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. Comyns Carr, "Book Illustration: Old and New."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the "Rivers Conservancy and Floods Prevention Bill," to be opened with a Paper by Mr. Evan Powell.

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. D. D. Dally, "Surveys and Explorations in the Native States of the Malayan Peninsula, 1875 to 1882."

Tuesday, May 9...Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. B. Tylor, "History of Customs and Beliefs." (Lecture IV.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Thomas F. Harvey, "Coal Washing."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Institution, 4, St. Martin's-place, W. C., 8 p.m. 1. Mr. J. Beddoe, "The Evidence of Surnames as to Ethnological Changes in England." 2. Mr. J. Park Harrison, "The Survival of certain Racial Features in the Population of the British Isles at the present day."

Royal Colonial Institute, 136, New Bond-street, 8 p.m. Mr. J. Harry, "The Northern Territory of South Australia."

Wednesday, May 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Spencer Walpole, "The Fish Supply of London."

National Society for Preserving the Memorials of the Dead (at the House of the Society of Arts), 3 p.m. Inaugural Meeting.

Geological, Burlington-house, W., 8 p.m. 1. Mr. P. Herbert Carpenter, "The Relations of *Hybocrinus*, *Baerocrinus*, and *Hybocystites*." 2. Mr. Ernest L. Jones, "The Exploration of Two Caves in the Neighbourhood of Tenby." 3. Mr. R. F. Tomes, "The *Madreporaria* of the Inferior Oolite of the Neighbourhood of Cheltenham and Gloucester." 4. Mr. H. J. Johnston-Lavis, "Notes on the Comparative Specific Gravities of Molten and Solidified Vesuvian Lavas."

Microscopical, King's College, W.C., 8 p.m.

Institute of Bankers, in the Theatre of the London Institution, Finsbury-circus, E.C., 6½ p.m. Mr. R. W. Barnett, "The National Banks of United States, America."

Thursday, May 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. Alexander M. Chance, "The Recovery of Sulphur from Alkali Waste. Schaffner's Process. A Record of Recent Results."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Cave Thomas, "The Revised Theory of Light. The Harmony of Colours."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Metals." (Lecture IV.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Professors W. E. Ayrton and John Perry, "Measuring Instruments Used in Electric Lighting and Transmission of Power." 2. "The Technical Education of an Electrical Engineer."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, May 12...Royal United Service Institution, Whitehall-yard, 3 p.m. Lieut.-Col. G. F. Fosbery, "Magazine Rifles."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. A. G. Vernon Harcourt, "The Relative Value of Different Modes of Lighting."

Astronomical, Burlington-house, W., 8 p.m.

Philological, University College, W.C., 8 p.m. Paper by the Rev. W. A. Harrison.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Saturday, May 13...Geologists' Association, University College, W.C. Excursion to Redhill and Crowley.

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Pollock, "History of the Science of Politics." (Lecture IV.)

Errata.—P. 600, col. 2, line 7 from bottom, *for* white and the grey chalk, *read* white chalk and the green sands; p. 601, col. 1, line 32, *for* which *read* each square inch of which; p. 601, col. 1, line 42, *after* water *read* if cost be no object; p. 607, col. 2, line 12, *for* west side *read* east side; p. 607, col. 2, line 22, *for* Romsey *read* Romney.

Journal of the Society of Arts.

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FRIDAY, MAY 12, 1882.]

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the fourth course of Cantor Lectures on "Book Illustration, Old and New," was delivered by Mr. J. Comyns Carr, on Monday evening, May 8. The lecturer opened the subject with some remarks on the proper relation of printed text and illustrated design, and then traced the history of the art from the period of the old illuminated manuscripts. He afterwards dealt with the characteristics of early wood engraving as exemplified in the old block books, and subsequently, in the books printed with moveable types, and concluded the lecture with some remarks on the divergence of modern wood engravers from the principles of the early artists.

The lectures will be printed in the *Journal* during the autumn recess.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 14th June. The cards of invitation will be issued shortly.

EXHIBITION OF MODERN ENGLISH POTTERY.

The arrangements for the Exhibition of Modern English Pottery, to be held at the House of the Society, are now completed. The following firms have, on the invitation of the Council, kindly consented to exhibit specimens of their work:—Messrs. T. C. Brown-Westhead, Moore and Co., Messrs. Henry Doulton and Co., Linthorpe Art Pottery Company, Messrs. Maw and Co., Messrs. Mintons, Messrs. Wedgwood, and the Worcester Royal Porcelain Works. The Exhibition will be opened on Monday, 22nd of May, at 10 a.m., and will probably be kept open every day from 10 to 4, until the end of June.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

A Catalogue of the Exhibition will be issued with the next number of the *Journal* published after the opening of the Exhibition.

The Council regret that owing to the limited space at their disposal, they are unable to avail themselves of various obliging offers of additional objects which have been made to them.

COMMERCIAL EXAMINATIONS.

In consequence of applications received from certain of the Institutions in Union, the Council have determined to revive the Examinations in Commercial Knowledge, discontinued in 1880.

The Council trust that the response made to this intimation will show that they were justified in acceding to the application.

It is obvious that the continuance of the Examinations must depend on their practical success, as evidenced by the number of candidates offering themselves for examination.

The Examinations in Commercial Knowledge will be held on Tuesday, the 20th, and Wednesday, the 21st June.

The Examinations in Political Economy, Domestic Economy, and Music will be held on Thursday, the 25th May, as already announced, and under the conditions stated in the Programme issued last November. No alteration whatever will be made in the arrangements of these Examinations.

The Commercial subjects for the present year will be—

1. Arithmetic.
2. English (including composition and correspondence, and précis writing).
3. Book-keeping.
4. Commercial Geography and History.
5. Shorthand.
6. French.
7. German.
8. Italian.
9. Spanish.

No Examination will be held in any subject for which less than 25 candidates offer themselves.

Certificates in two classes will be granted in each subject.

A fee of 2s. 6d. will be required from each candidate in each subject.

Committees having candidates for examination must apply, on or before the 1st of June, to the Secretary of the Society of Arts, for a form whereon to make their application for examination papers.

A programme of these Examinations can be had on application to the Secretary.

INDIAN SECTION.

The meeting announced for May 26th, is postponed until June 2nd.

Proceedings of the Society

EXTRA MEETING.

Friday afternoon, April 28th; EDWIN CHADWICK, C.B., in the chair.

The CHAIRMAN—I beg to premise that our proceedings of to-day are mainly due to our late lamented colleague, and my early friend Sir Henry Cole, who had on all occasions given zealous special support to the promotion of measures for mixed physical and mental training as in elementary schools on the half-time principle. In 1870, he exerted himself in making personal representations to the Education Department in support of the conclusions which had then been derived from the inquiries made in this Society, as to the superior economy and efficiency of graded schools, and various educational institutions on this system. He lately pressed the withdrawal of my attention from measures of sanitation for a renewal of inquiries as to the working of the Code, for which an educational committee was re-appointed. It is due to state, that the consequences of the representations made on the first inquiry, have been declared by the elementary school teachers to have been detrimental, mentally, physically, and morally. The evidence recently collected, chiefly in the metropolis, has shown the evils of the physical conditions of the children to be so much worse than was anticipated, that Sir Henry moved that the evils of the neglect of the physical condition should be dealt with again, and as distinctly as might be from the working of the Code, or anything else, and that our colleague on that committee, Dr. Richardson, should be requested to give a distinct public exposition, in which the physiological elements should be more distinctly displayed in their due relation. It is in compliance with the motion of Sir Henry Cole, at our last meeting of the Committee, and on the invitation of the Council, that Dr. Richardson will make the exposition, which I now beg him to give us.

A lecture was delivered on—

NATIONAL NECESSITIES AS THE BASES OF NATIONAL EDUCATION.

By BENJAMIN WARD RICHARDSON, M.D., F.R.S.

We have been discussing, for some weeks past, at the London School Board, the question of higher education, and after many debates, have not, as yet, arrived at a satisfactory conclusion. In the course of the debate, two contending principles have been brought out. On one side it has been enthusiastically declared that teaching of a higher standard than that now common is essentially necessary, both for the teacher and the taught; the teacher feeling the tax of one continual grind on elementary subjects an intolerable burden, and the taught failing to receive what might, in many instances, prove to be the inestimable blessing of a superior education. On the other side, it has been urged, with great earnestness, though of course not with enthusiasm, because enthusiasm can only be allied to aspiration, that the business of the Board ought strictly to be confined to the objects of securing a plain and elementary education for the many thousands of pupils it has under its care; that the development of higher class teaching should rest with those who have the means of paying for it; that if the basis be laid for sound elementary instruction, all who desire to obtain a better class education, will themselves find the means; that, practically, the present system gives the scholar the key by which he opens the door that leads from the region of darkness to the region of light, so that, being in the light, he can go whithersoever he will; and that, as a consequence, every attempt to do more in the elementary school is a departure from economy, and a misappropriation of the funds which the members of School Boards hold in trust from the public.

For myself, I have taken no part in this debate, except to listen attentively to it, and try to extract from it that which seemed to be useful; and the lesson I have learned is, that in certain ways, both parties concerned are in the right and in the wrong. I entirely sympathise with those who say that the present labours of the schoolmaster and schoolmistress must needs be a burden that becomes a daily cross; must be disheartening to a degree that those of us who are engaged in varied pursuits can scarcely recognise; and though very grand in its results, must seem as disappointing to those who are engaged in it, as the mere laying of a foundation of a grand cathedral pile must have been to those who failed to live to see the structure rise beyond the ground, and become what it ultimately would, the admiration of hundreds of succeding generations.

I am not without sympathy, at the same time, for those who reason on the economical side. I agree with them, that when a child of fourteen years can read well, write well, and calculate well, he has done as much as he ought to be allowed to do in that way up to that period. If he be forced to do more in form of brain-work, he is forced to do what is physically wrong for his body's sake, so much power of work required for his nutrition having been extracted simply for the development of mental aptitude and accretion. I am quite sure, indeed, that in a future and a wiser day, when the physics of life are better understood, and when men and women generally have determined to live the whole term of life instead of one-third of that term, they will not care for their children to be troubled with book-lore at all, previously to that first important physical stage of life marked out by the first of the seven stages which ends between the fourteenth and the fifteenth year. I sympathise, on yet another ground, with the economicals, namely, that to prime the young with the idea that they are only to learn while they are young, is to crystallise them into old men and women from their first, and of a certainty to shorten their life; because learning is as necessary to perfected life as bread, and because the happiest human existences are the existences of those persons who are always slowly acquiring knowledge, in its endless variety of form and character, and who, as they grow older, apply what they acquire the more wisely, effectively, and satisfactorily.

Why, then, it will be asked, if you feel these views, have you not used your right to express them from your place at the School Board? I answer at once, that my views would not have been in order, if expressed, inasmuch as they would not have related to the subject actually under debate. The question under debate has been for more book-learning, and more expense, by the first section; and for no more book-learning, and no more expense, by the second section of speakers. I do not sympathise with the first on the matter of increased book-learning; I do not sympathise with the second in favour of mere economy for economy's sake; and therefore I could not expect to be considered in order on the particular subject under discussion.

But there is another question, which no School Board as yet has touched, and which no School Board can touch, until the public mind has become familiar with it, namely, whether the present system of national education is based on the national necessities. In a few years this will be the leading topic of the School Boards everywhere; at present it is in that embryonic condition in which it can only expect to be tended and nurtured by such a Society as this, which, as our late distinguished and lamented colleague, Sir Henry Cole, once told us in Council, has for its first duty the duty of becoming the nursing mother of new and useful products of thought, until the nation takes them up, and puts them into business as her own offspring.

It is for the purpose of bringing forward this new aspect of the educational question that I stand before the Society to-day. I ask myself if the system of education at present going on in our nation, is a system which has a proper relation to the necessities of the nation. I look round me, to see the nation in chaos of thought and action; in what Mr. Gladstone has correctly defined as social revolution in one part, and mental revolution in all parts; mental revolution that might, by merest accident, by one or two days' shortness of food, from failure of foreign supply, and panic thereupon, pass, after a few years of further chaos, into physical revolution. And the thought which occurs to my mind, as it must to all who think, is, are we educating to prevent catastrophe? Are we educating the young to become useful, independent, and capable working members of society, ready to work with muscle as well as brain, in orderly and profitable form, or are we educating them to become mere troublers without design, repiners without hope, schemers without self-endurance, masters of the forces of nature herself, knowing how to use them for temporary, selfish, insane objects, but not knowing how to apply them for splendid purposes and for the general good.

Let me at once say, that this apprehension, and I may add comprehension, of a great national question, is not mine. It was advanced by Bentham, it was enforced by George Combe, and, before either of these great men wrote, it was formulated and insisted on by Gall. But the man who has the longest and the most earnestly advocated this view, urged it, pressed it, in season and out of season, for forty years or more, who has never lost his grasp of it, but has held it up to this hour unflinchingly, is our present chairman, Mr. Edwin Chadwick.

The national necessities as the bases of national education, are, first and foremost, these. That although in the early days of youth the three simple elementary educational practices of learning to read, to write, and to calculate, are necessities for the time, they are comparatively valueless unless combined with further necessities of a physical kind—namely, sound and systematic muscular training; freedom of breathing, and circulation of the blood; practical training, so that the body can be structurally built up and sustained in health; preparation for all duties requiring precision, decision, presence of mind, and endurance; and readiness to acquire any craft or handicraft that may bring a useful living. In a word, an education that shall bring the mental and physical qualities of every person into faithful harmony and goodwill.

It will be clear, from these expressions, in what way I agree, and yet differ, remain with, and yet stand apart from, my colleagues at the School Board, in their recent discussion. I, like some of them, would break up the monotony of the schoolmaster and the schoolmistress, and would give those excellent workers as much variety of teaching as any of them could desire. But that variety should be physical, not mental; play, rather than work; training of the muscles, and, I may say, of the skeleton too; of the lungs, of the heart, of the digestive organs; of brain and nerve for action —not of brain alone, and again brain, and brain, hour by hour, all the day long. I, like others of my colleagues, would encourage economy, not by keeping things as they are, but by saving some part of the two-fifths of the money now expended on teaching to spell, and by laying it out in teaching how to walk with grace and ease; to sing with correctness; to swim; to learn the use of the arms, and fingers, and hands; and to become men and women in the strict sense of the word, without danger of retrograding a hair's breadth in the Darwinian line.

I said, in my address at the Health Congress, at Brighton, what was quite true, that I had never in my life seen a healthy child, by which I meant, that I had never seen a child that had not in it, either some actual or latent constitutional disease. Touching the subject now in hand, it is equally true to say that it is all but impossible to find, in the Board schools of our large towns, any semblance, critically viewed, of health. Constitutional taints, which under favourable circumstances may often be concealed, and which may, or may not, be apparent, are there. Various conditions of disease are there, independently of the tendency from heredity; there of themselves, in some irregularity of body or limb, in some imperfection of sense, in some deficiency of quality of blood, in some feebleness of respiration, in some nervous irregularity of function, in some shade of mental aberration.

The field of disease which is presented in some of the schools situated in crowded localities is indeed a sight at once for anxiety and pity. To the eye of a physician who, like myself, has spent many years in dispensary practice, it tells a story which is absolutely painful, if he permit the results to be calculated out in his mind at leisure hours; if, that is to say, he compares what he has witnessed in his survey with what he has learned, from long observation, of the meaning of the phenomena in the history of life. It is not necessary to strip the children, percuss and sound the chest, examine the spine, or practise any of those refined arts of diagnosis with which he is familiar. He reads from the indications of temperament, of expression of countenance, of colour of skin, of position of limb, of build of body, of gait, of voice, sufficient outward manifestation to discern what is the true physical state, what is the stamp and extent of disease, what is the vital value of the lives generally that are before him. Tell him those lives are to be valued for some monetary purpose, as they stand and as they are to go on, according to the present system, and he will give in brief time an estimate of value which the keenest man of business might readily accept and act upon.

Foremost amongst the evils which are thus presented to him are those conditions of disease known as anemia and cachexia. Strictly, these are not diseases like diabetes, bronchitis, or defined affections having a regular course, but they are states of diseased form, which by their presence indicate a faulty nutrition at the period of life when good nutrition is most required, and which cannot long go on without ensuring the construction of an impaired bodily organisation. The blood is not being duly oxygenated, and food, therefore, though it even be fair in quality or quantity, is not properly applied. The nervous system is imperfectly built up; the skeleton is imperfectly built up; the muscular system is imperfectly built up and sustained. How can the improvement which is called scholarship be turned to fitting account in such recipients of it. I watched recently, the afternoon working of a large class of scholars, and counted one-third of them under the most decisive influence of these conditions of disease. Of the affected, there would not be, in the ordinary averaging of life, twenty years of existence under the course that was being followed. The one saving clause in their case, was development by physical training, and that was withheld. The one destroying clause in their case was over mental work, without the physical training, and that was assiduously and regularly supplied.

With or without the anemia and cachexia, there is the constitutional disease, struma or scrofula, present in these classes. The instances of this kind in varying degrees of intensity, are most numerous. This condition again is a mal or bad nutrition. It, as much as cachexia and anemia, with which it is so often allied, is fostered by the prevailing system of mental pressure.

With these two conditions before the eye, there is to be seen here and there in the classes, of both sexes, but of the girls especially, the specimen of the phthisical or consumptive subject. In a class of fifty I pick out three thus doomed, if their circumstances be not changed, six per cent., certainly a moderate proportion. The disease has not positively developed, but the probability of its development is all but certain, unless it be checked by the one or only remedial or preventive method—freedom from nervous exhaustion, combined with physical exercise in open breathing space. Such preventives are not supplied, but undue nervous exhaustion and confinement are both supplied, and so the fatal disease is systematically fanned from latency into activity.

Spinal deformity and irregular construction of the skeleton is another condition of disease, or actual disease, readily detectable in these classes.

Miss Löfing, speaking of her experiences as to the girls which have come under her notice, reports what is but too true, that they are, as a rule, very flat-chested, that there is evidently much spinal distortion, and that lateral curvature of the spine is common amongst them. This, which I may state, in parenthesis, is equally true in respect to boys, is accounted for by Miss Löfing in terms which show that the present school system does more than simply permit the mischief that is progressing, it actually fosters it and promotes it. Asked "To what the effects are chiefly ascribable," she replies, "A part is ascribable to home neglects; but the greater part of it is due to excessive and prolonged constraints under the common school conditions: too long sitting on badly constructed seats (that, as to seats, is in course of correction); but, with good seats, they are kept in bad positions in long writing exercises. The common bad position is, indeed, prescribed by the Government School Inspectors. I have found that, to obtain the school grants, the children are so constrained as to exclude the exercises that are needed for their bodily development. For example, I visited one school, where there was a class of children (of girls), who were stated to be of an average of about eleven years of age; they were generally of a pale, sallow complexion, though they were from a good neighbourhood. I asked the schoolmistress whether these girls had any exercises; she said, 'No, they had none—they had time only for the preparations for the examinations.' Did she, I asked, give them any play? 'No, they had no time for play; they had only time for the preparations,' She said that if she could make two weeks out of one, she might then get time for exercises. Another observation she made, upon my suggestion that they really ought to have some exercises, was that exercises would be difficult, as the girls had stays on. These little girls of eight years of age with stays on! The fault is want of knowledge, in the School Department, of the bodily constraint imposed by the preparations for these examinations, and that pressure is really now being extended to the infant schools."

It is right to put these matters of fact prominently forward, and it is quite easy to do so, without suggesting from them that the evils are worse than they were in some past times. In truth, things are better than they were. It is infinitely better for these children to come out of their wretched homes into the schoolroom to be educated, than to remain in their homes all day; and we are not, for a moment, contending against the school system, on the argument that the children should not come to school. Our argument is, that the children being at school, should have all the benefits derivable from the supervision under which they come, and nothing but the benefits.

Mr. Charles Roberts, in a letter which he has addressed to Mr. Chadwick, puts this question forward in words I should entirely endorse. "I may observe," he writes, "as the result of my study of this subject, that there is a little exaggeration in the prevailing opinions on the rapid degeneracy of the physique of our labouring classes in towns, and that it is not nearly so great as it is often represented to be. The great improvements in sanitation, which you must look on with special satisfaction from the part you have taken in bringing them about, and the recent improvements in the medical treatment of children's diseases, have more than counterbalanced the injurious effects of town life. I think, however, the evils of the physical degeneracy of our labouring population is a very urgent question for the present, and the immediate future. I think children are being very cruelly used by the Legislature. It took nearly fifty years, and half as many Acts of Parliament, to emancipate them from the injurious effects of excessive physical labour; but the result has been merely to transfer them from one taskmaster to another—from the manufacturer and their own parents to the schoolmaster; and to subject them to mental strain and physical inactivity, more injurious to their future well-being than their former condition. I look on your proposal to introduce the half-time system into schools, as a sort of mental "Factory Act" of the utmost importance and urgency, and the establishment in elementary schools of systematic physical education, as absolutely necessary to prevent great physical degeneracy in future."

These are some of the serious evils which attend the present school system. I have dealt only with the most important, and I am glad to say that many minor evils, which are talked more about, such as short-sight, strabismus or squint, club-foot, or other local deformities, are really not so prevalent as is generally believed. There is sufficient of gravity without taking them into our consideration at all.

In a minor degree, the health, not only of the scholar, but of the teacher also, is imperilled. We know well now that, in the adult stages of life, the constant sedentary occupation, capped by the monotony which springs from the perpetual following out of one pursuit, cannot fail to be attended with premature degenerative changes of tissue, leading to premature nervous enfeeblement and old age. On this point the more thoughtful of the school teachers are themselves agreed; and the school teachers of Scotland, who can hardly be surpassed in practical shrewdness and knowledge, have long declared that the present methods of teaching introduced by the Code are injurious—mentally, bodily, and morally.

To return to the children. The present system is, in their case, not only a violation of physiological, but of psychological law. The powers of receptivity of the minds of children of different ages have been tested experimentally, with as much care as physicists take when they are treating in their experiments on the relationships of ordinary matter to force. You take a Leyden jar of a certain size, and you say you can charge it in a certain time from so many turns of the electric machine; beyond that you can do no more, you have reached the powers of receptivity of that jar. You can break it if you will, but you cannot naturally surcharge it. The powers of receptivity of the minds of children of different ages have been tested quite as carefully, and it has been found that the capacity for attention and retention is as measurable as in the physical experiment. Certain brains can take in so much, and no more, according to age. The capacity grows with cultivation, and skilful teaching, no doubt, but it must be permitted to grow. In the very young a lesson of a minute may be all-sufficient. Later, of three minutes, five, ten, fifteen, and so on, to one hour, two, or three. But to this, there is limit, and it is probable that, with the best scholar of primary school age, the powers of receptivity rarely extend beyond a period of two hours-and-a-half of direct teaching. Teachers of various districts, and of different countries, have testified in respect to this point, and while they have explained, from direct observation, that the receptivity varies in different children according to difference of temperament, physical health and build, as might very well be expected, the receptivity at one time, in all children, ceases at the end of three hours. This view will, I doubt not, be fully supported by our chairman, who, in his report on the physiological and psychological limits to mental labour, made to the British Association for the Advancement of Science in 1860, reported as follows:—

"In one large establishment, containing about six hundred children, half girls and half boys, the means of industrial occupation were gained for the girls before any were obtained for the boys. The girls were therefore put upon half-time tuition, that is to say, their time of book-instruction was reduced from thirty-six hours to eighteen hours per week, given on the three alternate days of their industrial occupation, the boys remaining at full school time of thirty-six hours per week—the teaching being the same, on the same system, and by the same teachers, the same school attendance in weeks and years, in both cases. On the periodical examination of the school, surprise was expressed by the inspectors at finding how much more alert, mentally, the girls were than the boys, and in advance in book attainments. Subsequently, industrial occupation was found for the boys, when their time of book instruction was reduced from thirty-six hours a week to eighteen; and after a while, the boys were proved, upon examination, to have obtained their previous relative position, which was in advance of the girls."

I recall, too, how in the same report the exposition of this practical truth is sustained by our illustrious countryman and friend, Professor Owen. So clear, so terse, so true, is this exposition, I make no apology for presenting it again to the public, after its long rest of over twenty years.

"All the nutritive functions and actions of growth proceed," says this master, "more vigorously and rapidly in childhood and youth than in mature life, not merely as regards the solids and ordinary fluids, but also in the production of those imponderable and interchangeable forces which have sometimes been personified as nervous fluid, muscular force, &c. Using the latter term to amplify my meaning, the excess of nervous force is in the child most naturally and healthily reduced by its conversion into muscular force; and at very short intervals, during the active or waking period of life, the child instinctively uses its muscles, and relieves the brain and nerves of their accumulated force, which passes, by the intermediate contraction of the muscular fibre, into ordinary force or motion, exemplified by the child's own movements, and by those of some object or other which has attracted its attention. The tissues of the growing organs, brain, muscles, &c., are at this period of life too soft to bear a long continuance of their proper actions; their fibres have not attained their mature tone and firmness; this is more especially the case with the brain fibre. The direct action of the brain, as in the mental application to learning, soon tires; if it be too long continued, the tissues are unhealthily affected; the due progress or growth, which should have resulted in a fibre fit for good and continuous labour at maturity, is interfered with; the child, as an intellectual instrument, is to that extent spoiled by an error in the process by which that instrument was sought to be improved.

"The same effect on the muscular system is exemplified in the races that are now trained to run at two-and-a-half or three-and-a-half years old, for the grand prizes at Doncaster or Epsom. The winner of the Derby never becomes an Eclipse or Flying Childers, because the muscular system has been overwrought two or three years before it could have arrived at full development, which development is stopped by the premature over-exertion.

"If the brain be not stimulated to work, but is allowed to rest; and if at the same time, the muscles be forbidden to act, there then arises, if this restraint be too prolonged, an overcharged state of the nervous system. It is such a state as we see exemplified in the caged quadruped of active habits, when it seeks to relieve it, by converting the nervous into the muscular force, to the extent permitted by its prison, either executing a succession of bounds against the prison bars, like the agile leopard, or stalking, like the lion, sullenly to and fro.

"If the active child be too long prevented from gratifying the instinctive impulse to put in motion its limbs or body, the nervous system becomes overcharged, and the relief may at last be got by violent emotions or acts, called 'passion' or 'naughtiness,' ending in the fit of crying and flood of tears."

It would be impossible to add a word that would emphasise this graphic and remarkable exposition of natural law. It is a picture as truthful as it is forcible, and it forms a truly fitting conclusion to the argument I have so far made it my endeavour to set forth, as the physiological foundation or institute of educational improvements.

Proposed Reforms.

From these considerations let me now turn to the reforms which we, who are urgent as to reform in the present educational system, have in view. I have conveyed all along in this discourse this current thought, that the present system requires a radical change, in which the physical shall at least halve the time of the mental education. For this desire there is, we maintain, a reason and a method. The reason is the first point to be adduced. We reason, that the existing system is not a basis for the national necessities. We are of opinion, that in the future the education of a mental kind now being supplied will be imperfect and doubtful, nay, it may be of dangerous use, unless it be so laid out with physical culture that a perfect, or comparatively perfect, health of body shall go with it and sustain it. We urge that as we must either educate health or disease, it is best to educate health.

The design we have in view, then, includes several heads, which we say embrace no more than is absolutely necessary as bases of the national necessities. I may arrange these heads in the following order.

Physical Culture of the Body.—We urge that education should be so distinctly physical, that the body should be in no respect less improved than the mind at the close of the educational career. We follow, in this regard, the teaching of the Platonic philosophy, in which the master insists that the symmetry of mind and body be cultivated and maintained, without which there cannot be beauty, there cannot be health. We urge, that this is the only sure way of keeping up, in our country, a strong, and vigorous, and independent population, that shall understand how to utilise the home resources of land and industry, and keep the land and industry in the possession of our and their descendants.

Life-learning Tendencies.—We contend, secondly, that the education of the young of all classes, and of the poorest classes chiefly, should be so framed as to lead to the inducement of making the acquisition of knowledge a taste instead of a task, a pursuit instead of a labour. We contend that if the present system is pursued—in which children who are not by heredity born to mental occupation, and who are not physically privileged to acquire information, are, by sheer force driven through the hard and fast lines, fenced out by the books called standards, at a pace that shall make them complete their education irrespectively of temperament, health, ability, before their thirteenth or fourteenth year—the pressure, amounting in every case to a hardship, will merely have the effect of causing them to cease to learn when the pressure is taken off. We insist upon this, that the system shall be so modified that there shall be no mental pressure at all, but a mixture of mental and physical teaching which shall bring the mind into desire for knowledge after it is freed from the necessities to acquire it.

Aptitude for Productive Ability.—A third advancement upon which we lay great stress, is that the educational system shall be of a kind that shall render the body of fitting aptitude for productive ability. We argue that unless discrimination is used by the teacher for detecting the natural, or, so to speak more correctly, hereditary capabilities of the scholar, there must be failure in result of the most serious kind; failure that will tell upon all the productive industries of the country, so that agriculture, the various industrial arts, the various labours which call for muscular skill, activity, and endurance, will be sacrificed, or largely reduced in effective value. On this topic I have before me a letter written to Mr. Chadwick by Mr. Isaac Ashe, a Fellow of the King's and Queen's College of Ireland, from the Central Criminal Asylum at Dundrum, Dublin, over which establishment the learned writer presides. I do not think I can do better than quote his exact words on this part of our subject:—

"Persons, he observes, used to continuous brain-work, and who have an inherited capacity for it, ignorantly compare the standard of mental toil attainable by themselves or their children, with that attainable by the descendants of generations of manual labourers. But they might as reasonably set their own children, at ten or twelve years of age, to undertake the continuous daily labour of a navvy's son of the same age. I have no doubt but that the system of half-time schools which you advocate, is the true solution of the problem of how to train to intellectual tasks the dull minds of the humbler classes. It is easy to see how the healthy discipline, and regulated training in some artisan's trade or handicraft will save from crime those whom mere intellectual task-work will surely relegate thereto. To work healthily, either with mind or body, is a habit; and brain or muscle acquires the habit of using up the energies of the body in a particular direction. Such a habit, when once developed, becomes hereditary, and constitutes in any individual's descendants a capacity for a particular kind of labour, not readily to be broken through or set aside. If the young are forced to break altogether with their hereditarily acquired and normal tendencies and developments, while yet they have been unable fully to mould themselves to a different rule, it is easy to see that their development will be abnormal and unhealthy. But the habit of, and capacity for, manual labour is necessarily much more easily acquired by the children of generations of manual labourers, than are the habit of, and capacity for, brain-work. Hence, to develop and direct into healthy channels and courses of operation, the muscular energies of such children, must always be an easier task, and one more congenial to them, than that of developing a new capacity—to them almost a new function of brain tissue, that, namely, of studying and thinking.

"The hereditary tendency of the children of criminals to lapse into crime must also not be overlooked. The question is—How can it be eradicated? This can probably be effected only by directing into healthy channels the nerve and brain habits, which will otherwise act spontaneously in morbid and criminal directions; and the channel into which these can most readily and with most ease be directed, is undoubtedly to be found in something which will call into action the same mental and physical aptitudes as those which the hereditary career of crime shall have developed. If, for instance, the child of the clever forger is taught draughtmanship, the hereditary proclivity to a criminal use of an instinctive faculty will be directed into an analogous yet healthy channel, and probably, with the result of at once curing the tendency towards crime, and turning out a skilful artisan. If the children of generations of pickpockets are taught to use their criminally deft fingers and delicate touch in some handicraft requiring such a capacity of finger, such as watchmaking, filagree work, &c., a healthy function will be found for a nervous proclivity and muscular aptitude, which will otherwise fairly work itself out in the criminal acts to which its very existence forms an almost irresistable temptation. The children of the burglar might be found, similarly, to have an hereditary aptitude for a blacksmith's trade, and so on. And thus, criminality will be eradicated by directing the hereditary faculty into a healthy and normal channel of exercise. But to attempt to abrogate it utterly, or eradicate it as a criminal tendency, without such utilisation of it in a healthy direction, will prove futile.

"*Naturam expellas furcâ tamen usque recurret.*"

Which I would freely translate as follows :—

"Though you may check Nature by matter of force,
She will take her own way as a matter of course."

In insisting on this practice of developing productive ability, we are sustained by the belief that nothing could be lost by the effort in the way of actual education. We are of opinion that the time saved by the adoption of varying conditions of school work would prevent the injuries now incident to the fixed rules under which the educational system is enforced, and in this view we are supported by the opinions of the most practical teachers.

Mr. Imeson, late of the Central District School of London, whose authority, based on extensive practice, stands high as a teacher, objects to the Code that it has rested erroneously on rigid lines of demarcation. He observes as follows :—

> "The mental endowments of children are so varied, that great elasticity of method is needed in teaching them. This, the inspectors as a rule ignore, being bound to a cut and dried rule of inspection. Whatever is likely to develop intelligence may be commented upon in Blue books; but the ordinary tests of the inspector are mechanical, and made to catch the unwary, overleaping the proper course to be pursued. There is a saying, 'as is the master, so is the school.' This used to be true, but now it might be said, 'as is the inspector, so is the school.' This is mischievous beyond ordinary observation, for the inspector generally owes his position to his attainments, which are presumed to be of more avail in a school than the teaching skill of a *bonâ-fide* education."

Lastly, we submit that, to ensure the future happiness and serenity of the people of the future, the children of the present should have their mental and art training varied by making the subject of recreation a scientific branch of study amongst all who are engaged in educational work. In such advance, we should have the means for recreation made the means for imperceptible instruction in bodily and mental powers, so that, having never unduly severed them from the tastes of the scholar, they shall be true resting places, useful as well as pleasing diversions from mental and physical labour.

CONCLUSIONS.

I have now put forward our programme. It is framed on what we conceive to be the basis of national necessities. A few concluding paragraphs may be taken as proposed resolutions to explain the mode in which we would carry out the reforms we have in view.

1. We propose to lessen the tasks of a mental kind in all schools, by the introduction of what is practically a half-time system. Believing that the brain of the child under fourteen years of age is sufficiently charged, to be safely charged, when it has been subjected to three hours work in book teaching, we assume that this period per day of such teaching is sufficient for all useful and safe advancement, that the children would have more than they could learn, and would retain more than they need retain on this plan. We propose at the same time to make inspection into such book learning less critical and less severe, with an institution of inspection into physical capability as a part of the inspection, in place of the part given up to book standards.

In connection with this department we propose that there should be at stated times a physical inquiry, by competent authority, into the health of every school and every scholar, and that as much special encouragement and reward should be given to scholars who present the best physique as to those who present proofs of superior attainments in the standards.

We propose further that this great change shall be effected by utilising the time thus taken from books in application to lessons of play, exercise, or work that shall be useful in developing the body, and in making it apt to attain proficiency in physical arts and sciences. We would suggest that, in the school itself, the means for this physical instruction should be provided; but we would not by any hard and fast line hold by the school as the only place. If it were found in any case that a scholar had the means, in his half time, of following any proper and profitable occupation without injury to himself, we should let him follow it, by which plan, as we believe, the sting of the compulsory clause in the Education act would be most effectually blunted.

2. We propose, that while the mind of the child shall not be surcharged with book-learning at a time when the body is in the most critical stage of development either into a sound and helpful or into an unsound and helpless body, there shall be made a provision in the school itself, by which education shall be allowed to go on after the usual prescribed time, in which it is presumed that the education is completed. In this way, we believe, the Voluntary and Board Schools would become not only schools for the young but colleges for the old pupils, and, in respect to the older pupils, self-supporting centres of popular enlightenment.

3. We propose, in the introduction of physical education into schools, that it should be at once of the simplest and best kind; not a system of one particular character, but one which should combine everything that is useful in various systems, and which should interest the scholar, while it developes his physical life. We agree with an observation made by Mr. Charles Roberts, in the letter from him already quoted, in which he says:—

> "I have examined with some care, from a physiological point of view, the various systems of physical education, but I am not satisfied with any of them. The military drill in use in many schools, puts too great a strain on the lower limbs, and too little on the arms and trunk, and though the exercises are useful for discipline, they are monotonous and wearisome to children, and may be injurious, by inducing flat-foot, and other deformities of the body. On the other hand, the exercises in ordinary German gymnasiums are generally too severe for children, and not sufficiently under the control of the non-medical teacher; their expense, moreover, places them beyond the reach of elementary schools. The Swedish system, again as taught in the Board schools, lacks spirit and energy, from the entire absence of apparatus, and, therefore, of motive, to attempt or complete a definite object—a defect which Miss Chreiman's system has removed to considerable extent, by the limited use of simple apparatus."

4. We propose that there should be introduced into the system, what may be shortly explained as systematic training of the senses, so that the senses of sight, hearing, touch, and even smell, should be brought up to the best standards of perfection, Such training, we are of opinion, could be carried out by means of lessons and of simple apparatus, and would, in the course of carrying it out, afford facility for practically testing the capacity of every scholar, and his fitness or unfitness for the after duties he may be called upon to undertake. In America, they have had appointed tests for the proof of colour sight, so that it may be determined, when a man applies for duties in which colour-sights are required, whether he can distinguish colour. If our design were in operation, no scholar would leave a school without being made fully acquainted with his particular failure or capacity for this and such like occupations.

5. We propose, finally, to use the time that we wish to extract from book-learning, in some, and, indeed, in a free degree, to the cultivation of certain of the more refined and pleasure-building arts. First amongst these, we would place music, as the primitive of recreative pleasures. We observe that our children are well and happy when they can sing; we see men and women gathered together, and find the height of mirth and happiness when somebody gives a song or a tune. In the most refined society, music is the joy of life; in the lowest dens, men, hardly above animals, when they meet to be amused, sing. It may be that in all these positions the music is very bad, but it is there, and it extends through creation. Here, therefore, is the first recreation to be scientifically studied. Make a nation, we say, a musical nation, and think how you have harmonised it, socially, morally, healthfully. We cannot begin to teach this recreation too early, or too soundly.

We ought to begin by making the learning of notes in succession—the scale of musical chords—coincident with the learning of the alphabet. The one could be taught as easily as the other, and would be retained as readily—perhaps more agreeably. Next, the intervals should be taught, in a simple but careful way, so that melody may be acquired, and the art of sight singing attained. From this elementary basis should follow the simplest forms of time, after which a plain melody could be read with as much ease as the reading of the first story-book. Simple part-songs, leading to endless delight, would succeed in exercise; and a true and natural language in sweet sounds would be the property, in one generation, of all the nation. In addition to music, we would, as a matter of course, introduce other pleasant recreations, such as dancing, gymnastics, and all those muscular games and exercises which, by discharging naturally the nervous force, relieve the mind of mischievous intents and provocatives to destructive habits.

This, Mr. Chairman, is the programme we would put before the nation, in respect to the grand revolution we consider necessary, of placing national education on the basis of national necessities. Should it be urged that what we propose is too essentially physical or muscular, we answer that all education is, in the strict sense, physical and even muscular. Speech is muscular, expression is muscular, writing is muscular, composition is muscular, as much as mental. It is as purely a muscular act to decline a Greek verb, as to walk across a tight rope; only that the muscular movement, hardly so refined, is more obscure. We meet two men, one of whom is seen to move with ease and grace, the other with dullness and weight. We say, how accomplished the one—how uncouth the other. We hear two men discourse—the one with elegance, precision, style, the other with hesitation, blundering, rudeness. We say, how accomplished the one, how uncouth the other. In all these cases, muscular force has played its equal part with mental aptitude, or inaptitude. We see a man who has not been educated to grace of manner, or speech, or thought, assuming the part of a man of grace, manner, and thought, and, by much study, sustaining the character for a short time, as on the stage. But we know that man only acts; he is not trained to the muscular skill that can carry him through all parts of life with equal grace, though he may, by intense labour, attain a minor part, and be perfect in it.

We know that no one who late in life enters a vocation requiring certain qualities, like that of a physician, a surgeon, a preacher or pleader, a commander, a pilot, an engineer, a player, can gain that full self-possession which comes, as it is said, naturally, to the man who has been from early life trained in the work. Here again the failure we affirm is muscular as much as mental. The concealed muscular mechanism is not in working order. The mind may issue its commands, but if the muscles fail to obey, the mind, like a general whose redcoats are undrilled and impervious, may break itself to imbecility and produce no results beyond hopeless and helpless confusion and dismay.

So we contend for the physical education of all our young, on the lines I have laid down, as the stirring want in this stirring time. Our intention is to make this nation a nation of heroes as well as scholars; a nation that the sculptor can describe as well as the historian; a nation that can hold its own in the scale of vitality, and protect its own by the virtues of courage, physical prowess, and endurance, as ably as by statesmanship and knowledge, more ably than by expediency and craft. In all which efforts, Sir, we accept, and act on the motto which you have rivetted on our standard—

"Primo vivere, deinde philosophari."

DISCUSSION.

The CHAIRMAN—I think it will be agreed by all present, that the great paper we have just heard fully realises the anticipations of the mover for it, Sir Henry Cole. I will only add that the statistical results of the partial working of the principles set forth, in institutions comprising some forty thousand children, are to give to two pupils the efficiency of three for productive industry, and that their general application would add one-third to the productive force of the population of the whole country.

Professor BAIN said he had listened with the greatest attention to the discourse, and if the last five minutes had been removed, he could almost literally have agreed to everything which the lecturer stated. Up to the last five minutes, Dr. Richardson retained the words of truth and soberness, but after that he got enthusiastic, and carried his hearers farther than they were prepared to go. The real burden and strain of the discourse, he took to be, the physical improvement of the population by whatever resources were within their power; and the only resources more immediately in question were the National Schools. Of course, no one knew better than Dr. Richardson that the National School was but one part of the means at hand. The whole system of large towns required to be remodelled and adapted for this great object, but unquestionably the school was at their own command, and they ought there to do the utmost in their power. He was sorry to say, he concurred but too heartily in the opinion as to the insufficiency of the present school system, for having lately been taken to see several of the new schools at Birmingham, one or two things struck him very forcibly as bearing out what had been said by Dr. Richardson. In one instance, the girls' school was on the second floor, and upon asking the mistress whether the scholars were allowed any time for play, he was told they were not, as it would take so long for them to reach the playground—that the ten minutes for play would be occupied in going and returning. Upon this flimsy pretext, the children were kept for five hours in the school-room. Of course, the rural population were in a totally different position, as they had a considerable distance to walk before reaching the school, and among them Dr. Richardson would find many perfect specimens of health. Having regard to the exigencies of the problem, he thought what Mr. Chadwick had been striving to accomplish, and Dr. Richardson had that day expounded, namely, the reduction of the time for lessons, would go a long way towards meeting the difficulty, and the improvement of the senses, by cultivating music and daning, would all come in due time. His own opinion was that the subject of elocution should receive a little more attention, in order to spread the art of easy and accomplished speech, and thus to improve the population in this respect. In conclusion, he begged to propose a hearty vote of thanks to Dr. Richardson.

Earl **Fortescue**, in seconding the motion, said they had, at great cost, established training colleges for instructing teachers how to teach, but training institutions were wanted to teach the Educational Department what to seek in the way of education—what to press upon the nation and what to repress. The movement of the Department had for a long time been more and more unsatisfactory; they seemed to consider how high a standard they could possibly coerce the hapless children of this country into passing before they were allowed to earn their daily bread. Serious industrial inconveniences had ensued, which might cheerfully have been acquiesced in, if those having studied sanitary requirements a little had not been convinced that these industrial inconveniences were caused by what simultaneously was doing harm, to a great proportion of the children in school. There could be no doubt that the long hours in school, for many years, had deteriorated the physical condition, without at all adequately improving the growth of mental power in the children. It had been a sort of hothouse system, and, as Dr. Richardson had said, the coercion employed to force an undue amount of learning into children, at too early an age, tended to produce a distaste for subsequent intellectual work; and the utter absence of any healthy vent for hereditary aptitudes, tended, in many cases, to lead children to misapply those aptitudes, in violation of the laws of God and man. He wished he could believe that the effect of the schools of the present day was at all what the sanguine promoters, and especially the bureaucratic promotors of education, flattered themselves it was. His own idea was, that the system in schools being an unhealthy one, had rather encouraged, contrary to the intention of the authors and promotors of State education, by the reaction, a certain roughness and brutality in the youth of this country the moment they were emancipated from school. On moral as well as physical grounds, he believed a great part of the reform so ably advocated by Dr. Richardson was very desirable.

The motion was put to the meeting by the **Chairman**, and carried unanimously.

INDIAN SECTION.

Friday, May 5th, 1882; Sir **George Campbell**, K.C.S.I., M.P., in the chair.

The paper, which was read by Dr. Mouat, was—

EXPERIENCES OF AN EUROPEAN ZAMINDAR (LANDHOLDER) IN BEHAR.

By James Mylne.

The following remarks are a reproduction of personal experiences during the construction of the East Indian Railway, and subsequently on the Jugdespore zamindary, in the Shahabad district of the Patna division of Bengal, with some reflections, not by way of argument or discussion, but offered for what they are worth to the Chairman and the audience.

The estate or zamindary is known in the collectorate as the Jugdespore Jungle Mehal, the proprietors or zamindars being the firm of Burrows, Thomson, and Mylne.

In 1855, Messrs. Burn and Co. of Calcutta, opened work on their contract section of the East Indian Railway, beginning at Phoolwari near Dinapore, and extending across the Soane River, 160 miles west to Mogul Serai, near Benares. Mr. Henry Burrows was managing partner on this work, Messrs. Thomson and Mylne with others, were agents managing sections of the works.

Perhaps only those who were engaged on these or similar works can realise what a huge practical school the construction of railways has been and is to the labouring classes of India. The professors and teachers in this school had no language in common with their pupils, except the work itself interpreted by signs and gestures and some strong adjectives mixed with broken English and shattered Hindoostani. But the pupils were observant and intelligent, and the unusual remuneration in hard cash kept them at school.

The progress made on their side was wonderful. Here is an instance:—" Ramchurn 'tum gaya' that there 'godown' and bring them there 'chabbees'" (Ramchurn you had gone into that store-room and bring those keys). So ordered an English ganger or plate-layer, and had not Ramchurn, the coolie labourer, made greater advances than his master, the inverted tense and the jumble of words would have had no meaning for him. An engineer in charge of a section of the line, was giving certain instructions in what he considered good Hindoostani, the man addressed listened attentively, and then replied in his vernacular, "Cherisher of the poor! I do not understand your English." A civil hint to the engineer that his progress in the vernacular had not been satisfactory.

At first Bengali interpreters were placed with the Europeans on the line, but as they were called, and soon found to be, rather "interrupters," they were dispensed with.

Teacher and pupils were thus left to their own devices as to the interchange of ideas. The former got a bag of rupees, some hoes, baskets and brick-moulds, a strip of rice-field for a school-room, with a brazen sky for its ceiling, and set to work to teach his pupils to construct that special product and necessity of the 19th century, a trunk line of railway.

The pupils belonged to all castes and classes of the native population, attracted by the bags of rupees which the (to them) nondescript Europeans evidently had. They had no previous experience in similar work, and it may be said we could adopt none of their methods. Most of the Europeans learned little or nothing from them, not even their language. Used as they had been to bricks 3-inch square, by an inch thick, it was difficult, at first, to get a man to look beyond the ends of the 9-inch or 10-inch brick which he was placing in our work. A quiet passive wonder at the incomprehensible iron road to be made—which should do more than their hero-god "Rama," who could convey only himself from Hindoostan to Ceylon in three steps—and its equally incomprehensible representative moving about by himself, to and fro amongst them, and the appreciation of a steady daily or weekly pay beyond their usual earnings, were their only qualifications. That they were made the most of, is seen by the wonderful results achieved.

On the one side, a semi-nude coolie with knowledge enough to move, in certain definite directions, his limbs and fingers, as well as toes, when occasion required; a generally empty stomach, and a clear, inquiring eye. On the other side, the magnificent railway system of India, the solidity and finish of which will compare not unfavourably with similar works in Europe and America. The brain power which moved this mass of human levers was embodied in a well-arranged corps of earnest Englishmen—engineers and their inspectors, contractors with their agents and assistants.

Hitherto, away from the large towns and centres of trade, the natives had, as a rule, known only the two classes of Government servants, civil and military. Indigo planters were too few and isolated to be known by any other name than "nil wallas" (or blue men). The civilians were then, as now, the "sahibán," or "sahib lôg," which term also included military officers; the European soldiers were "gora," or whites. The higher grades of the railway staff were soon elevated into the "sahibán" region of respectability, but the others in railway employ remained another kind of the "gora," or whites, with the gratifying distinction, however, that though, as a rule, using language not easily understood, of doubtful sobriety—and, now and again, at variance with his wife—"he loves his work, and does it well."

In the East, labour is not regarded as specially honourable, but in the European, as an expression or embodiment of power to effect, achieve, and do, it receives respectful recognition from all classes of the native community which come in contact with it—even though embodied in a form, the antipodes of the gentle and deferential Hindoo, such as that of the English navvy. In this may be recognised an unobtrusive element, reaching down to the bottom of the native constitution, which, like their "punchayet" system, or Court of Arbitration, carries with it the seeds of future progressive possibilities for their regeneration as a people. The writer has often been told, "Ap lôg ke jât ka kûch kâh nahin jata; Brahman ke sath Brahman; waqht par râjpoot, kaesth, girhast, burhai, lohár, muzdoor, wuh bhi ap log hain," which, shortly rendered, means, "Your caste is incomprehensible; you are each and all by turns — a Brahmin with Brahmins: soldier, accountant, cultivator, blacksmith, and carpenter, as occasion may require."

All this is expected of us, collectively and individually, and if it can be realised in private and public life, Afghanistan will desire to become in reality, what it is geographically, a part of the Indian system, and the Russians will not grasp the Solaiman Range from either Herat or Afghan Turkestan.

Thus, in July, 1857, Europeans and natives were quietly at work, constructing the East Indian Railway, when three regiments of Rajpoot Sepoys mutinied at Dinapore, and made straight for Arrah, where they found a band of 16 Europeans and 50 Seikhs, in a small house, which had been partially fortified by Mr. R. V. Boyle, one of the engineers of the railway. News of the storm raging and the dangers encountered elsewhere, had led Mr.

Boyle to arrange for some stand being made in the event of a sudden attack or rising. The fortification was only partial, as no means were available for efficiently protecting the lower storey, and a very few determined men attacking the base could easily have forced an entrance, when protected and supported by the two or three thousand rifles of their comrades.

Arrived at Arrah, and getting possession of fifty or sixty thousand rupees, then in the local treasury, the leaders of these Sepoys sent an invitation to Baboo Koor Sing, of Jugdespore, to lead them against the "feringhi." The Baboo, as he was usually called, was one of those Rajpoot zamindars whose ancestors, some generations previously, had subjugated the aboriginal rulers of the country, and, subsequently, had themselves been compelled to pay tribute, first to the Mogul dynasty, and later, to the British Government, or to that wonderful organisation of British energy and enterprise, known as the Honourable East India Company, popularly in India, as "John Company," or "Company Bahadoor."

The officials who settled Shahabad at the time of the permanent settlement, appear to have recognised the claim of Koor Sing's family to hold, as zamindar or landlord, an estate so large that, besides a considerable area of jungle, it included more than 2,000 villages, with the cleared and cultivated lands around them, ranging from 200 to 5,000 acres per village, from all of which, so long as he paid regularly the Government "Jumma" or "land-tax" fixed for each village, he was entitled by law and ancient custom to take rents, payable mostly in kind, and usually about one-third to half the produce. The amount which, with good management, such an estate was capable of yielding was, of course, enormous, and with such management, Koor Sing might, in 1857, have been in receipt of a princely income. But the Baboo and his predecessors appear to have given to field sports and such diversions so much more time and attention than they did to the management of this fine estate, that a few years prior to 1857 he was in a position very similar to that in which our large landed proprietors in England sometimes find themselves, owing to gambling, dissipation, or neglect. The mahajans (or money lenders) were insisting on payment, and had begun to foreclose their mortgages, when, with the help of the local officials, an arrangement was effected for paying them off gradually, Koor Sing being allowed a sufficient sum for his yearly expenses. Koor Sing was above 80 years old when the mutinous Sepoys sent a deputation to request that he would become their leader against the Government and power which had thus recognised and helped him. Partly because slights which he considered he had received from some recently appointed officials, and partly (as is supposed) hoping to effect a shorter settlement with his creditors, Koor Sing yielded to the temptation, and so had his estates confiscated. He is said to have been a fine soldierly leader, and to have been free from personal blame for the cruelties perpetrated by some of his followers. Seeing how little the 3,000 Sepoys were able to accomplish in Arrah, without the leading of their European officers, he is said to have upbraided them: "You could take Bhurtpore for the 'sahib lôg,' but cannot take this small house for me; I am disgraced and dishonoured."

Arrah was relieved by a small force of 150 rifles, with 70 men of the Bengal Artillery, and 3 guns, who marched under Major Eyre from Buxar, 45 miles west. The advance of the relieving force had been materially aided and facilitated by the co-operation of the agent and assistants of Burn and Co., who were appealed to for carts, tents, coolies, horses, saddles, and other indispensables, and who, being asked to show the way, themselves joined the force as volunteers. This small band of less than 250 Europeans were met about ten miles from Arrah by a force three or four thousand strong, the bulk of it being well armed Sepoys, in possession of the arms and ammunition which they had carried off from Dinapore and other places. The relieving force was not to be denied, however, and after a couple of very sharp and hot engagements, in the latter of which some of the principal leaders of the Sepoys fell, the thousands gave way before the 200, and the brave garrison of Arrah was relieved. Koor Sing with his followers betook themselves to the Jugdespore Jungle, the whereabouts and extent of which are shown by the map on the wall, which is a tracing of the map made by the officers of the Bengal Engineers, as part of the great trigonometrical survey of India, one of the grandest works ever accomplished or undertaken in that line.

The survey maps of 1844-5 show the Jugdespore jungle as it was then, the large town and bazaar of Jugdespore being nearly in its centre. This jungle was surrounded by a fringe of tall grass, and outside of that by the cultivated lands of surrounding villages, all belonging to Koor Sing, who was, in reality, the caste head and leader of the Oojein Rajpoots, numerous and influential in the Shahabad district, and long settled there.

The jungle began one mile north of the railway, and extended southwards about 20 miles, covering an area of 35 or 40 square miles, and was kept as a cover for game. There was a shooting-box or bungalow 6 miles south of Jugdespore, where officials and other European gentlemen, often spent pleasant days as guests of the Baboo.

The subsequent events of the mutiny forced Koor Sing and his followers to go south and west along the Kymore hills, towards Rewa, and thence, by Cawnpore and Lucknow, round to the north of the Ganges, opposite the north end of the Jugdespore jungle.

I believe the majority of the men of the three regiments of mutineers from Dinapore were Oojein Rajpoots from Shahabad, many of them being sons and relatives of Koor Sing's tenants. The rebels reached the north bank of the Ganges in time to effect a partial crossing before our troops reached the river in pursuit. The artillery opened fire on the boats yet on the river, and in one of them, as was afterwards learned, the Baboo received his death wound. He was carried to Jugdespore, and died in his own home on the same night on which he arrived there. The railway work was stopped in July, 1857, and was resumed in December, but was again suspended by this return of Koor Sing and his men from the north-west or north, in April, 1858.

It is a matter of history, how Captain Legrand, then in Arrah with a small detachment of Europeans and Seikh troops, marched on Judgespore a few days later, was driven back in disorder, and his men pursued by the rebels, and slaughtered, only 100 out of 300 of the Europeans returning alive. The mutineers were thus able to hold Judgespore and the surrounding villages during the wet season of that year, entrenching themselves by constructing a trench and bank having a circumference of six or seven miles around Judgespore. It became evident that the jungle must be rendered untenable as a cover or stronghold before the district could be properly tranquilised.

Burn and Co. of Calcutta, who had, at the time, command of a large amount of labour, were invited to undertake it, and the senior partner of the firm, not caring to take an interest in a lease of the jungle lands, Mr. Henry Burrows—who was managing partner of the railway works—himself, as lessee, undertook it, provided the needful protection were given to the Europeans engaged in it. Previous acquaintance and experience gave the people, who had been working on the railway, confidence in Mr. Burrows and his agents, so that within a few days some hundreds of axemen and clearing coolies were at work, protected by the troops under Brigadiers Lugard and Douglas. The jungle cutting was begun early in May, 1858, Lugard and Douglas being there with their European troops, but in June Lugard withdrew his men to Arrah, leaving Captain Rattray with his Seikhs to protect the axemen, and the Europeans superintending them. The rebels were found to be gathering in numbers in the villages adjacent, and in June Rattray followed with his Seikhs, Mr. Burrows with his agents, assistants, and natives, going at the same time. Many of the axemen and coolies seeing the danger threatening them had already disappeared. The jungle cutting was resumed in October when Brigadier Douglas was in command, and was continued till it was useless to the rebels as a cover and refuge.

To secure the future peace of the district, it was necessary to clear the jungle root and branch, and bring the land into cultivation, and by the terms of the lease 1,000 acres were to be cleared and rendered fit for cultivation within the first year, and the same area for the second; the lease being for fifty years with a right of renewal in perpetuity.

Thus, with Mr. Henry Burrows, Mr. Walter Thomson, and the writer, a European zamindary was established, with its centre at Jugdespore, which for generations had been the headquarters of Koor Sing's family.

To facilitate the demarcation of boundaries and other of the arrangements connected therewith, forty-five of the adjoining villages were subsequently leased along with the jungle land.

As the mutiny had left these villages in a state of comparative ruin, with fields uncultivated and people dispersed, our position, as well as the work before us, was peculiar and exceptional.

It has already been mentioned, that though Koor Sing's estates were extensive and capable of great improvement, he was deeply in debt. Such men as he was have little knowledge or experience beyond their surroundings, and these are the reverse of beneficial. One of India's great wants is a body of zamindars with energy, intelligence, and public spirit, as well as capital, between Government and the masses of the cultivators.

The Hindoo or Mahommedan zamindar knows his countrymen, but though possessed of the means, leisure, and capacity of obtaining it, he has less practical knowledge than the poorest of his tenants. As his forefathers before him have done for generations, he is content to live on his tenants, without an effort to give them any return. He claims the advantages of his station as a divine right. What are his tenants, "Dulloo Koir," "Ajaeb Koormi," "Achaibur Kandoo," "Purtab Sing," and their families to him, but the means "Purmessur" (Providence) has, in the natural course of things, provided him with, for paying the "Sircar Bahadoors Kist" (Government revenue), and keeping him and his in comfort and respectability?

The permanent settlement of Bengal and Behar may have been in some respects a mistake. The Government of that day had its own difficulties, political and financial, which, perhaps, were greater than economists of these days can realise. Nor could the India of the present, with its thousands of miles of railways, and some magnificent irrigation works, have been foreseen any more distinctly than we can venture to say what will be a century hence. But, whether in permanently settled Bengal and Behar, or in the temporarily settled North-West districts, the zamindar has not done his work; nor is it different in the Ryotwar districts of Bombay and Madras, where Government is in the position of zamindar.

The native zamindar is the product of his habits and surroundings, and the work of Government officials in civil employ is onerous enough, irrespective of any attempt at individual interest in the affairs of the cultivator of two or ten acres of land. However honest the intention of such an attempt might be, a new "tikkus" (tax) of some kind would be suspected by the cultivator. Thus the ryot or cultivator has to bear not only the burden of his own ignorance, but that of those whose duty it is to help him in improvements. Like his own patient bullock, he has a vague feeling that the burden of life is a heavy continuous drag over a heavy road. The comfort of the animal is in the absence of reflection, and of the ryot in his fatalism. "It is 'Ramjees' order and so far right."

The first duty of a zamindar, Government officials hold to be a strict and regular observance of the "Sundown Law," for the solvency of the Indian Government rests mainly on the land revenue, and the machine-like regularity with which it is realised. Certain quarterly dates are fixed, on which the "Kists" or instalments of rent must be paid into the collectorate Treasury before sundown, failing which, the estate of the defaulting zamindar is liable to be sold by public auction to the highest bidder. A collector's sale for arrears of Government revenue, conveys with it a title which takes precedence of all claims or liabilities whatsoever. This law seems severe and unreasonable, but under the circumstances is probably at present a necessity. The tendency of its operation is the selection and maintenance of the best men available as rent collectors, and it compels a certain amount of forethought and economy.

As European zamindars, we found ourselves in contact with, and even factors in, what were to us, very peculiar social conditions. The ryots, though individually small, weak, and insignificant, beyond their own households, are, from their numbers, in the concrete, huge and powerful in results; but the ryot does not realise his relation to the concrete, and hence his individual stagnation. His concrete is his caste, or section of caste, which dictates his habits, aims, and ends, in all the duties and relations of life. He has no nationality in our sense of the word.

In justice to the numerous individual interests committed to our charge, we had to make ourselves acquainted with the influence of the various caste distinctions on individual character, both socially and morally, in order to meet individuals, however diverse, on their own ground, or as if we were one of themselves —to know them individually and by name, and to be easy and agreeable with all the heads and leading members of families on the estate. We find that the observance of this duty, though requiring much time, patience, and tact, is quietly and gratefully acknowledged by the people, and its benefits recognised, both by them and ourselves.

They look on the obligation to pay a fair and reasonable rent as a natural duty, which is forcibly expressed in a proverb of four words, in the Shahabad vernacular, and used by one of our Rajpoot tenants, "Jahan pôth tahan ann" (where there is rent there is produce).

There is a meaning in this, which Mr. Parnell and the no-rent Irish might do well to analyse; but perhaps the social ethics of our Aryan brothers, outside the Christian pale, are beyond their grasp of intellect or honesty of purpose.

To the usual zamindary duties were added, in this instance, of the Jugdespore estate, a resettling of people in the villages, a gradual resumption of agriculture over all previously cultivated but then waste areas, the finding additional people to root, clear, and cultivate 8,000 acres of jungle land, some 3,000 acres of virgin land covered with tall grass, besides much fallow land in the villages, the occupiers of which had disappeared during the mutiny.

Numbers of our railway labourers followed us to the jungle, and took up land. Considerable portions were also taken up by caste combinations, under one or two intelligent leaders; and the confidence and security enjoyed by them, added to the plentiful results of a slight cultivation of virgin soil, attracted others, singly or in smaller groups. The population on the jungle lands now numbers 688, and that of the village portion of the estate, 1,464 persons per square mile, the reason of the difference being, that village residents cultivate jungle land also; the average of both is 1,195. Middlesex (extra metropolis) has 1,082, and Lancashire, 1,493 persons per square mile.

There was an unexpressed influence at work which may have increased their confidence and content. A right to hold land at fixed rates of rent is their greatest ambition, and is a mark of respectability among village neighbours. It is difficult, if not impossible, to render the meaning of the vernacular term "Kheel már" into such a condensed form in English. Literally it is "peg driven," and they held the belief, privately, that "Kheel már" gave them proprietary rights in the land. The term may be practically held to mean the first opening of the surface of the soil for the purposes of cultivation, even to the limited extent of driving a peg into it; a very comprehensive charter of rights!

The Behar ryot, in reference to his zamindar, is usually represented as being much oppressed, long suffering, and helpless; but this is not true as regards the Shahabad division of the province. The most numerous section of the cultivators of this district are Rajpoots, Brahmins, and Aheers, the fighting classes of India, and from these sturdy Septs were drawn the "Poorabeea" or "Eastern" Sepoys, who never failed to follow wherever led, and who supplied the bulk of the material by means of which we have succeeded to empire in India, and brought peace and the possibilities of progress to distracted down-trodden populations.

In the past it was the custom of these classes of cultivators to manage and deal with their zamindar very much as suited their own convenience, and in place of realising from them what he considered to be his right, he had to rest content with what he could get.

The law and custom of distraint recognised in the old regulations, and, in a modified form, incorporated with Act X. of 1859, has tended very much to induce more orderly conditions for both ryots and zamindars. The crop is held to be hypothecated for the rent of the land on which it is grown or growing; and if the arrears of current rent are considerable, the zamindar gives the ryot a legal notice of distraint at his place of abode in the presence of the village accountant (putwari) and watchman (chowkidár). He must also, within three days, notify such distraint to the nearest Civil Court, at the same time filing a statement of account between himself and tenant. Crops can be thus destrained only for rent due for twelve months prior to the date of distraint. Arrears of older standing must be sued for in the Civil Court. When the crop is distrained, a watchman is appointed by the Court to see that it is not removed till the rent is paid. If not paid within a certain time it is sold to the highest bidder, and all proceeds, less cost of distraint, are credited to the tenant. This "law of distraint" is very much older than Act X. of 1859. It is in fact a law and custom which has come on to us probably from time immemorial. At any rate, it is to be found in the laws which were in force when "John Company" succeeded the Mogul and other powers in the administration of the country, and it was made British law in Bengal by the regulations, Acts, or laws passed before the present Legislative Council had any existence.

The rule and order at present followed is an exceedingly simple and inexpensive one for all concerned, is well understood, and, except where abused, inflicts no hardship. The abuse can easily be guarded against, all the more easily, as the tenants, with their power of combination, are, year by year, becoming much stronger, and in most localities, are now more than a match for their zamindar.

In the draft of a new Rent Act for Bengal and Behar, it was proposed to abrogate the "distraint" sections of the existing Act. But were this simple inexpensive procedure set aside, and the complicated, dilatory, costly and unclean machinery of the lower Courts substituted for it, the change would assuredly prove to be a sore disaster for all concerned, tenant, zamindar, and Government. A class of men proverbially improvident and extravagant (where a wedding or any entertainment is concerned) would be likely to spend far more of their income than even at present on such things, would get deeper and deeper into debt, would be "advised" by designing mookhtears (attorneys) and others, that they may now please themselves as to paying their rent regularly. The zamindar being unable to collect it, would be equally unable to pay Government, and the inevitable consequence would be confusion to all concerned.

The Rajah of Doomraon, a large proprietor in Shahabad, pays Government upwards of 400,000 rupees (£40,000), year by year, out of what he collects from the tenants on his zamindary. Were such a change made in the law, our belief is that he would soon be unable to collect it, and, if the provisions of the sundown law be enforced, his estates would be sold by auction for arrears of revenue.

The case may be brought home to the audience by supposing that all the owners of houses, shops, and cottages in and about London, were not only deprived of the right, when rent is in arrear, to prevent, if necessary, the tenant removing his furniture, &c., until the rent be paid, or security given for it; but were, at the same time, put under the operation of a law which bound them to pay punctually, within certain fixed dates, heavy ground-rents, the penalty being that at the expiry of 14 days' notice, which may or may not have reached the owner, the property is sold away to the highest bidder, however low the bid may be, by collusive arrangements amongst the officials. There are many cases on record, in which men have lost their estates in this way. Here in London, it may be thought that only by gross neglect on the part of the owner, could such a disaster overtake a man, that he must be to blame for not knowing of the arrear and the danger. But take our own case in India; we are fourteen miles away from the Government Treasury of the district where the money has to be paid, and it has to be sent in rupees, this being the form in which we get it from the tenants. If owing to any failure to pay before sundown of the day fixed, information of which, owing to roguery and collusion, fail to reach us, we may suddenly discover that our estate, to the building up of which we have devoted twenty-four years of labour and a considerable amount of capital, has been sold away from us for a nominal sum. Quite recently in our own district, such a plot and scheme was successfully carried out in which for a small claim of an ordinary creditor a valuable estate was knocked down to some local lawyers attached to the Court for about 500 rupees, that is less than £50.

"I am in possession of the crops; the malik (proprietor) can't touch that now. It is a good season here, and all kinds of produce will be plentiful. Purtab Lall, the putwari (village accountant), has heard in the bazars that there has been very little rain in the Punjâb, and parts of the west country; crops there are poor, and our prices will be good. The *Jenéra* (Indian corn) sold well, and gave me Rs. 16. The rice is a full crop, and will surely be worth Rs. 100. Then there are the cold weather crops—wheat, barley, oil-seeds, and saf-flower—which will be worth, at least Rs. 60 or Rs. 70. And the sugar-cane—my 'jaggery' from it has generally a good grain and colour—will, in March, be worth at least Rs. 200; that is, in all, about Rs. 376. Janki Pursad, the court mookhtear, tells me that the moonsif (lowest civil officer) has 600 cases on his file, and that the case against me is not at all likely to be taken up for at least a year. Ram Sing and three or four others in this village have received Court summonses; and the putwari says 50 or 60 summonses will be issued by the landlord in other villages. Suppose he gains all these cases a year or two hence, and executes decrees against our property and holdings—none of our neighbours will purchase our land, houses, and bullocks. The landlord cannot profitably cultivate the land himself; if he tried to do so, what would become of the crops? Would he get any?—would they not be grazed down and disappear? After a while, he will be glad to let the land to any one who may be able to retain possession of it; and my second cousin is the only man in the village strong enough to keep my holding, and his own holding and mine could easily be worked in partnership. If there were indigo factories here, as in other parts of the country, the proprietors would gladly purchase our lands from the landlord, and we should be ruined. I will get Rs. 376 from all my crops in April; my case in Court will not be taken up for, say, twelve or eighteen months. My eldest daughter should be married now, my youngest son betrothed, and I have long wanted to visit the shrines of 'Kassi Ji' (Benares) and Hurdwar, to bathe and worship at these holy places. 'Juggernath Ji' (Poori) is too far off, and the railway does not go in that direction, but I could easily visit Gaya, and return in time to sow the early Indian corn, and even if that crop had to be foregone for one season, it would not matter. In the meantime, I must make the best arrangement I can with my mahajan (or money-lender)."

Such would doubtless be the form the temptation would take, under the proposed new Act. The elements of it are all there. Its influence and tendencies are as immoral and vicious as the working of the present law of distraint during the last 25 or 30 years has been found beneficent, and conservative of the best interests of ryot and zamindar alike ; the possibilty of antagonism between them is reduced to a minimum. The truth of the adage, "Short accounts make long friends," has never been better illustrated than in this instance, while a costly and sustained conflict of months, and perhaps years, in the Civil Court, would create a bitterness of feeling between landlord and tenant, which is not pleasant to contemplate, as taking the place of the present pretty general accord, the result of past wise and benevolent legislation.

The abrogation of the law of distraint would inevitably involve the abrogation also of the "Sundown law" in justice to the landowners, and this would probably mean the financial ruin of the Government of India, such a large proportion of whose income is derived from the land revenue.

It will for some time to come be far from easy to secure in India any full representation of the people by themselves, a serious hindrance being the existence of the caste customs and prejudices, which, to so great an extent, hinder them uniting for any common end, and render it impossible for men who hold such opinions as they do of their fellow men to initiate or support the enactment of laws which would be calculated to secure justice for all classes. But with the help of railways, schools, the press, and other influences, which are silently working, the natives of India are being gradually introduced to a different set of ideas, and what seems to be most wanted just now is free communication between the Government and the people. There is no lack of material or means by which such free communication could be opened up and established, and good use may be made of "Punchayet," or village committees, which are called together when any caste question, or local dispute, has to be arbitrated and decided.

The ryots know intimately the varieties and productive value of every square foot of their holdings classifying them by various names, some of which are given below :—

	Rental per acre per Annum.	
	s. d.	s. d.
1. *Kewal* } 2. *Karail* } Clay lands which will generally yield two full crops per annum......	12 9 to	16 0
3. *Bál.*—Sandy soil, with a sufficient admixture of loam to render it just fit to produce a crop	5 0 to	6 0
4. *Táur.*—A hard indurated water-bearing loam, capable of producing heavy crops of paddy, in the presence of abundance of water	1 6 to	9 6
5. *Rehchut.*—Same as No. 4, but not nearly so fertile because highly impregnated with salts	0 10 to	5 0
6. *Dih, Korár, or Goiur.*—Lands immediately surrounding the village houses, generally a rich garden mould, highly manured by human excrement and village sweepings, and set apart for raising the most valuable crops, such as the poppy for opium, sugar cane, and vegetables. These lands receive a "garden" cultivation, in contradistinction to "field" cultivation	25 6 to	38 3
7. *Tarri.*—Lands below or under, that is, further away from No. 6, and adjoining them, set apart for cane generally	16 0 to	22 4
8. *Dorus and Bhangar.*—Mixed loamy soils	9 6 to	11 3
9. *Bálmát* } 10. *Balgarh* } A mixture of sand and clay or loam	6 4 to	8 0
11. *Baltaur.*—A mixture of Nos. 3 and 4 above	6 4 to	8 0
12. *Taurgarh.*—A mixture of No. 4 and a little loam	6 4 to	8 0

Note on No. 4.—Where no artificial or natural means of irrigation exist, this land is hardly worth even 1s. 6d. an acre ; but if a plentiful supply of water is available, it is worth at least eight times as much. The rates of rent shown in the margin, are paid for lands having facilities for irrigation from canals.

As the quality, especially of new or virgin soil, varies considerably within limited areas, it was found advisable, for the purpose of localising and dealing with these varieties, to reduce the very irregularly shaped clearings reclaimed from the jungle into regular forms, shown on the map by red lines. These lines represent paths and roads, and inclose squares of 10 acres, or 16 local bigghas. Thus, the individual holdings are multiples of the biggha unit, and are indicated by black lines. This reduction to a definite regularity was, at first, looked upon with suspicion by the tenants, until they found in it the best ground and charter of settlement for all time between the zamindar and themselves as to areas, qualities of land, and rates of rent. It also assisted to localise definitely some 500 wells made in the jungle lands for irrigation purposes, before the construction of the Government canals began.

The rent law of Bengal and Behar recognises three or four classes of tenants. 1st. Those having rights of occupancy at fixed rates of rent, that is, if the same amount of rent has been paid during 20 years, and the land is proved to have been within a defined permanent boundary during that time, it is presumed to have been so held at that rental since the permanent settlement in 1793. Beyond 20 years, the onus of proof to the contrary rests with the zamindar. If the rent has been recorded at a certain rate per biggah, and, on measurement, the land is found to be less or more, a claim to a corresponding abatement or increase of rent could be sustained. If the boundaries have not been constant or definite, and more land were found in the holding than the tenant is presumably entitled to possess, the excess area could be resumed, or rent charged for such excess, at rates usual for similar land in the neighbourhood. 2nd. Those having rights of occupancy at a rental which may be enhanced, such enhancement may be made by mutual arrangement, or by a civil suit under definite rules, and for adequate legal reasons. The sections of the Bengal Landlord and Tenant Act regarding enhancement are wise and just enactments. 3rd. Tenants holding under a regular lease for a number of years, at such rates and upon such conditions as may be mutually agreed to. 4th. Tenants at will, whose lands may be resumed after service of notice to that effect, served at the end of the cultivating season. In the northern portions of Shahabad, right of occupancy under one or other of the above forms is the rule; further south, it may not be so, as the land there was not much in request before the opening of the canals. We are not aware of any reason why the acquisition of occupancy rights should not be encouraged by the zamindars. A tenant who has paid his rent regularly for twelve years, though probably a stranger and a wanderer at first, may be considered a permanent acquisition to an estate; but the zamindar is not likely to look at it from that point of view only, but also in connection with the broader question of the ultimate possible intentions of Government with reference to himself. The spirit and apparent aim of agrarian legislation does not tend to reassure him, less so the supposed bias of the local judiciary with whom he has at first hand to deal. On the advent of a new judicial officer, European or native, speculation is free as to whether he is biassed, or independent and fair. Should a subordinate judge or moonsiff be suddenly transferred, the presumption is that such transfer was made because of his having decided some important case in favour of a zamindar. The possibility of such sinister speculations is to be regretted, but reasons for them doubtless exist. Suspicion has not been modified by some recently proposed alterations in the law of landlord and tenant, such as reducing the term within which a right of occupancy may accrue from twelve to three years, thereby giving a vagrant right in the soil it may have suited him to squat on for 37 months in a temporary hut. It was also proposed to abrogate that complement of the sun-down law, the "law of distraint," which applied to crops on the ground, and for arrears of rent of one year only, and replace it by regular and costly civil suits in courts already overwhelmed with work. The probable baneful effects of this proposed change is referred to elsewhere. Recently, an official attempt was made to obtain a record of individual rights and tenures through the Putwaris, or village accountants. Forms were given to them containing 12 heads, one of which referred to the nature of each tenant's right in his holding, and orders were given that these forms should be filled up and returned in ten days. The zamindars received no notice of this order, nor of the issue of the forms, though they were expected to sign them before they were returned by the putwaris. Those who know how prone this poor and ignorant village official is to be obliging in the presence of a small personal consideration, will be able to estimate the use of such returns or information at their true value, for any purpose of justice or equity. The zamindars protested against this extraordinary method of defining the relations between the tenants and themselves. The attempt only added to suspicions, already too prevalent, of the aims and methods of Government.

Under such circumstances, zamindars are naturally unwilling to assist in weakening their own position. Were the law of distraint abolished, it is difficult to see the justice of retaining the "sun-down" law, unless all cultivators were declared to be merely tenants at will. The relation of landlord and tenant, in whatever form it may exist, should be one of confidence and mutual effort, each in his place honestly working for an end common to both —that is, a further development of the exhaustless "unearned increment of the soil." The aims and interests being the same, there need be no antagonism. Should such arise, it can only be the result of causes inimical to both, and, when looked for, may be easily found and removed. There was a time, in our part of the country, and probably in other parts also, when a ryot could threaten to, and did, throw up his land, if the terms of the landlord were not to his liking. This he did, well knowing that Government would demand from the zamindar the rent, or land-tax, on it, whether cultivated or not. Landlords and tenants to-day find themselves in very different circumstances, through no voluntary effort of their own; both feel the need of some definite official recognition of their relative rights, legal and social, as at present existing; and the hardship is equally felt, of being obliged to ascertain this by costly and irritating suits in the civil courts, where class feeling is intensified by suspicions of bias influencing the court. Looking at the matter from a local point of view, and with some knowledge of the disposition of the people, both landlords and tenants, we believe they would concur in any effort by Government to obtain an official record of individual rights and interests, if assured that the intention was purely this, and nothing more.

To this end, Government might order the interchange of registered documents between zamindars and tenants, which should give all necessary details as to the tenure or holding; non-compliance by either side, within a certain time, to entail a fine. Continued non-compliance to result, in the case of the tenant, of his being recorded as merely a tenant at will; and in the case of the landlord, to result in his tenant being recorded as having a right of occupancy at a fixed or variable rental, as the custom of the locality might suggest. We have long recognised the desirability of such an interchange of registered documents, and have repeatedly tendered "pottahs," or leases, while the refusal to give "kabooliuts," or counterpart engagements has been as frequent. Suspicion of the safety of taking leases, and giving counterparts, is almost universal; but if the contents and conditions of leases and counterparts were explained to them by authority, and under Government guarantee, the difficulty would probably disappear. Contested cases would have to be dealt with separately. Judicious local inquiry, and documentary evidence adduced by both parties, would in most cases lead to a just decision.

It should here be stated that by far the greater number of the tenants on the Jugdespore estate cannot be dispossessed of their holdings, so long as they continue to pay a fair and equitable rental. In the event of dispute on this point, the Civil Courts are resorted to; but since the estate was granted to us twenty-four years ago, we have had to take this step in only two or three instances.

To one living among the people, it is apparent that they look on the zamindar as a natural part of their social system, and on the differences with him more as a passing illness than as a deadly malady, that must be fatal to the one or the other. It is in the power of Government to increase this feeling indefinitely, not by sacrificing the rights or interest of either one to the other, but by securing a record of existing individual rights; among other benefits, litigation for this purpose would be reduced to a minimum.

The general level of the subsoil water is not more than 25 to 30 feet below the surface, and its raising and distribution is costly and limited, compared with the flow from canals. For the rice crop, it would be impossible to obtain sufficient water by well irrigation. In connection with means for the irrigation of rice fields in Shahabad, "Brooke Sahib" has immortalised his name among the cultivating classes of the district. They delight to tell us now how he taught the people of that day to make "ahras," or reservoirs, for the collection and storage of surface drainage water during the rainy season. An "ahra" is formed by an earthern mound, or "bund," varying from half to two or three miles in length, being thrown up across the drainage of the country. The hollow from which the earth is taken is the store or reservoir; the land on the upper side beyond this hollow is also submerged, and is named the "tal," or lake; that on the lower side, which is never submerged, is the "putsár," and irrigated portion, and is devoted to the cultivation of rice, carefully hand-planted. Arrangements are made at the ends of the "ahra" for the escape of surplus water, which is allowed to flow on to another "ahra" on a lower level of the country, and so on till the overflow of the last "ahra" escapes into a stream.

As the certainty of any crop thus depended on the local rainfall, which at best is very irregular and uncertain, "ahra" irrigation has been gradually superseded for rice cultivation by the certainty of the canal supply. Nevertheless, Mr. Brooke, collector and magistrate of Shahabad, about the end of last, or beginning of this, century, is gratefully remembered by the people as a benefactor.

The opening of the Sone Canals (navigable, branch, and distributary) opened a new era of hope and prosperity to the ryots over the extensive areas irrigable by flow or easy lift from the canals. As the supply of water during the rainy season is comparatively inexhaustible, the rice crops over much larger areas than heretofore may be rendered secure. It is likely the canal system west and north, and east and north, will gradually be extended, as the management and means of the field distribution of the water becomes better understood and perfected. This is necessarily a work of time and experience. Government does not make village irrigation channels. These have to be made either by the zamindars or by the ryots themselves. Some idea of the extent of this work may be got from the fact that the Jugdespore Estate covers an area of 23,000 acres, and for the proper irrigation of it, we have constructed 96 miles of village channels, at a cost of Rs.35,000 (£3,500). A great number and length of small field-to-field channels had also to be made. On the proper alignment and maintenance of these village and field channels depends very greatly the steady and economical supply of water. As a rule zamindars have not made channels. The ryots of each village generally combine to do so, and such channels become their property, with which the zamindar cannot interfere.

The opium question affects the agricultural classes of India to the extent of six or seven millions sterling yearly, and their social welfare to that extent; but it does not seem to have occurred to those Christian philanthropists who are so zealous in the cause of morality in one direction, that they propose by the strong hand of a professedly Christian power to deprive a helpless, non-Christian people of six or seven million pounds annually, without so much as even asking how they would like it. A highwayman or burglar could not be more unreasonable or unjust in the estimation of his victim. The Government of India must necessarily be a Government of and for the people. Its *personelle* may be composed of members of all the various creeds and persuasions of Christendom, Heathendom, and Pagandom. If, as is assumed by a few of their representatives, the tax-payers of Great Britain and Ireland feel themselves in any way responsible for the growth of opium in India, and (with these few men) can view it as a great national iniquity, they cannot consistently, with such moral convictions, purge the sin at the expense of a much poorer and subject people, who are not, and probably never will be, Christians; who do not understand or accept the ethics of Christianity, even when applied for their benefit, and who would be much less likely to do so, if, by the infliction of new taxes, they were made to pay for the prejudices and mental peculiarities of a foreign people who, for the time, happen to have power over them.

The six or seven millions earned for India by the cultivators of poppy would probably be covered by an additional 3d. in the pound for income-tax. The principles put forward in the name of the British people require that they accept this additional burden, and guarantee to the people of India the results obtained from an industry suitable to their condition, climate, and soil, before—by an act of sentimental legislation—they hand over that industry to other Eastern peoples, ready and waiting to accept so valuable a gift, and over whom the British public have no power whatever to say yea or nay.

When proposals are made for legislation in specific directions for India, it should be remembered that, politically, the people are in their non-age; that while sentiment may have a place in reference to such legislation, it ought to be controlled by a consideration of justice to them: and to secure this essential, a thorough knowledge of their social conditions, and mental and moral peculiarities, is necessary. Allowance being made for the difference in the moral atmosphere, the moral backbone of the Indian people will compare not unfavourably with that of the more favoured Christian races of the West.

It is necessary to remember that though, as yet, the populations of India have no political life, the caste angularities of their complex social life are being rounded off by their daily experience that the law of British India ignores caste; that in the Courts the Koolin Brahmin and the Dome (lowest of the sweeper caste) are equal. The encouragement and assistance given by Government to vernacular and the higher grades of education; the inevitable contact of caste with caste, and the opportunities for observation which the facilities for travel by the extension of railways give, all tend to the same changes. It was at first doubted whether people of different castes would travel in the same compartments, but when the carriage doors were opened, there was no difficulty whatever on that account. The numbers travelling are enormous. At certain times, when pilgrimages visit the holy places, covered goods waggons are filled with passengers, who spread their mats on the floor, and sit there with probably greater comfort than on the seats of second or third-class carriages. A well-known engineer on the East Indian Railway is reported to have said, in reference to first-class passengers, who numerically are few, that he thought it would pay the company to give every first-class passenger Rs.100 to go away and never come back again.

The vernacular press is silently and effectively at work. Its influence, though as yet in a small way, extends to remote villages and communities, and is addressed to the Indian people without reference to caste. That political and social matters are discussed, the following instance may be given. In a remote village, eighty miles from the nearest railway, a relation of the writer, while conversing on various topics (the Afghan War, the return of the Nawab Nazim of Bengal to Moorshedabad, after a fruitless mission to England, and on other matters) with an intelligent and well educated Mahommedan gentleman, who could not speak English, was asked, "Is it fair or just that your religious teachers, bishops, and clergymen, should be paid or assisted from the revenues collected from the people of this country, while our moollahs and the Brahmins have to be supported by private means?" Men of like intelligence, observation, and reflection, are to be met with in every village over the broad surface of India. They patronise the vernacular press, discuss its representations and teachings with their neighbours at home, they meet other travellers in the public "serais," or rest-houses, at railway stations, in crowded carriages, on long railway journeys, at fairs and holy places, the latest news is quietly retailed to many listeners, and the rumour of a new tax or law, intimately affecting themselves, receives careful attention; and if informed by the native press and its many readers, that an additional tax of six or seven crores of rupees was to be imposed on them, because a few people in England, to satisfy their personal ideas of right and wrong, had induced the Government to stop the production of opium for the people of China, such a reason for the infliction of a heavy additional tax—or if an occasional surplus were even devoted to that purpose, instead of to the removing of the license tax or any other unpopular imposition, or the construction of protective public works, such as canals, railways, and roads of all kinds—would be absolutely incomprehensible to Hindoo and Mahommedan alike. The Government would be openly charged with injustice and folly; cynical remarks would be made as to the demoralising effect on the lower classes of the extension and working of the Abkari or liquor laws, and the application of the revenue therefrom; dearer salt would be spoken of; tobacco, the comfort of the poor and the luxury of the rich, would be considered in danger; in short, the Government would be considered capable of any act, however unjust to them.

If the production of Indian opium for China is infected with the moral turpitude its detractors imagine, it will die a natural death, that is, the demand for it will cease, and the Government of India will be blameless in the eyes of the people; but if a valuable industry, specially adapted to the condition of the millions of small cultivators engaged in it were to be authoritatively taken from them, and, in adition to this wrong, a heavy tax were at the same time imposed upon them, or a chance surplus taken from them, for the doubtful benefit of another people, for reasons they cannot comprehend, they would have cause to complain of such unjust legislation, and they would do so loudly.

As stated above, the original draft of the new rent law included the two large and populous provinces of Bengal and Behar; the census of 1871-2 giving a population of forty-seven millions for the former, and thirteen millions for the latter, or a total of sixty millions. It cannot be a matter for surprise that further inquiry resulted in the discovery, that if legislation were to be attempted, Behar had to be specially considered, and that a still closer observation brought into prominence the fact, that Behar north of the Ganges, and Behar south of the Ganges, are as diverse as Behar is from Bengal. Such wholesome attempts at benevolent legislation (the motive is, however, good) may be the best possible under the present relative conditions of rulers and people, and the very superficial and limited knowledge they have of each other. It may also be advisable to attempt to simplify legislation in the sense of extending its area as far as possible, but a rational and beneficial legislation for the people must rest upon an accurate and intimate knowledge of their diversified social and physical conditions. European members of legislative councils cannot be expected to possess such extraordinary experience. Native members might be supposed to have an intimate knowledge of the legislative needs of their own localities, and of those only; but as rent or tax collectors living on the people, which is all they are at present, the value of their counsel should be acknowledged with necessary qualifications.

The great want is some means of getting a free expression of the sense of the people themselves, including that of the zamindars. There are many intelligent leading men among the ryots capable of dealing with agarian and social questions in every division of a province, but there is no means of obtaining such an expression of opinion on any question intimately affecting their interests. If applied to or consulted by a Government official they would suspect the motive.

Before the British ascendancy, recurring famines in India showed the necessity of utilising its enormous irrigation resources, and works of considerable magnitude indicate that respectable efforts by native rulers had been made in that direction, but the personal nature of the Government, with its consequent uncertainty and liability to sudden and violent changes, was against the efficient maintenance of such costly and complicated works, even if their construction could have been carried out to a really useful extent. Besides, in those days, as now, it would have been useless to make provision for more than local wants, if, at the same time, the means of carrying off superabundant produce were not at hand. There is also among the landed class a prejudice against the construction of canals by Government, arising probably from a suspicious jealousy as to the effect of such works on their individual influence amongst the people, and the knowledge through a third set of men, viz., engineers and their intelligent European and native assistants, of the working of their estates and the condition of their ryots; and, what would be most objected to, the opening up of the outer world to the ryots through the observation of, and contact with, this third set of men, who would be resident among them, and have business transactions among them. What might not be the result of such a breaking up of ancient privacy? Their personal dignity, honour, or influence might be in danger. To men not yet open to the perception that a public benefit includes the enhancement of private interests, such suspicions are natural enough. This opening-up is one of the collateral benefits of large irrigation works, and, in a politico-social sense, of great value; but the benefit is not of a nature to appear in rupees, annas, and pie on the credit side of the account.

A look at the map will show the enormous catchment area of the Sone Valley, to which is added that of the tributary streams, the Koel and its affluents, which pour the united volume of their waters, during the rains, round the eastern scarp of the Kaimore Hills, at Rhotasgurh, into the valley of the Ganges, on the southern boundary of Behar, where it meets that of the Palamow division of Chota Nagpore. This enormous volume of water has been for ages flowing waste into the Ganges at Dinapore, and thence to the sea, while successive thousands have perished of hunger on its banks.

The country on either side—the naturally rich and populous districts of Patna and Shahabad—is topographically remarkably well adapted for irrigation, being flat, but having a very decided, though gradual, fall in a north-easterly direction, parallel to the course of the Sone River, towards the Ganges. The people were accustomed to irrigation, and depended entirely on it for their crops. They had, especially in Shahabad, covered the face of the country with such earth-dykes, forming "Ahrás," as have been before described, some of them over two miles long, across and at right angles to the surface drainage of the country, to store up water for their rice fields. Cold weather crops, such as barley, wheat, pulses, opium, &c., had to be irrigated from wells. But these resources for irrigation depended entirely upon the local rainfall and surface drainage, which at best is fitful, and often untimely and unreliable for the purpose of steady agriculture. Results could never be relied upon, even in the most favourable seasons; and in years of local drought, or short rainfall, the reservoirs ("Ahrás") were dry, or the supply insufficient, the level of the subsoil water descended in the wells, and as the demand on them continued, it disappeared altogether.

The labour of raising a very limited quantity of water increased, when the people and cattle were least able to bear the additional strain. Under such circumstances, it might reasonably have been expected that the zamindars would gladly second the benevolent efforts of the Government in utilising such magnificent natural resources, for the benefit of their ryots and themselves, but the leading men amongst them maintained a passive, apathetic attitude to the project and progress of the works.

An Ashlar anicut, three miles long, was built across the Sone river (near the passage of the grand trunk road at Dihree), and certain large sections of the canals were opened for irrigation. Government then expected the co-operation and assistance of zamindars in leading the water to the fields of their tenants, by constructing small village channels, and in collecting water rates. They, however, drew up a memorial to the Government of Bengal, stating the water of the Sone to be ruinous to the soil, and inimical to plant life, that neither their tenants nor themselves stood in need of it, as they had reservoirs and wells of their own construction. A very considerable length of village irrigation channels had already been made on the Jugdespore estate—their total length now is about 96 miles—the ryots had had two or three seasons experience of the good effects and results of Sone irrigation, and this with such limited irrigation as the people immediately on the banks of the river had for generations practised; and occasional floods over lands further off, proved the beneficial nature of the water.

After receiving the zamindars' memorial, the Lieutenant-Governor of Bengal, Sir Ashley Eden, took occasion to visit the Sone Irrigation Works, leaving the East Indian Railway at Beheea, and passing through what was the jungle portion of the Jugdespore estate. The conversation *en route* had reference mainly to the zamindars' memorial. At the boundary of the Jugdespore estate, a dozen or so of our ryots were standing, who had beneficial experience of the full supply of Sone water, which our village channels had brought to their doors. The Lieutenant-Governor desired to stop, and he questioned the men. "Had they taken the canal water?" "How did they like it?" "Was it good for their crops?" "What was it worth to them?" As no reply was given to these questions, the writer suggested he himself should speak to the men; and said, "The Lord Sahib" (Lieutenant-Governor) having received a petition from the native zamindars, that the Sone water is bad for your crops, that you don't want it, and that it will ruin you and your families, has come here to stop all the works and fill up the canals; and the "Engineer Sahib," is also here to take the order and carry it out. There was then an immediate and universal response, "Dohai, dohai, lát Sahib Bahadoor! What do the zamindars know, if this is done our hope will be taken from us." His Honour the Lieutenant-Governor was satisfied that the view of the zamindars was not that of the cultivators, having proved the great value of direct communication with the ryots themselves.

No free and decided or reliable expression of opinion could have been got from these men, except by some such direct appeal to their interest and experience. Suspicious as to the motives of the questions previously put, closed their mouths.

In some parts of the country irrigated by the Ganges and Jumna canals, an efflorescence, locally called "reh" (or soda salts) appears on the surface of the land, rendering it useless for any kind of cultivation yet attempted upon it. The cause of this efflorescence is not clearly ascertained. Insufficient drainage, both surface and subsoil, has been suggested. As it sometimes lies on the surface of the infected soil in the form of powder, it may be blown about by the wind, or carried away by surface water, to lands which, till then, were not infected.

It has been feared that the Sone canals might develop saline efflorесence also. The following remarks may mitigate, if not remove, the fear of any such contingency. 1st. The canals have been carefully aligned along the ridges of the district. 2nd. Where surface drainage had to be intercepted, the requisite provision of syphons under the canals were, and are, being made to allow of its uninterrupted passage. 3rd. The lateral dip of the Sone valley portion of the country, from the Kymore hills to the Ganges, is much greater than the longitudinal dip of the Ganges valley, of which it is a part. 4th. There are numerous veins of coarse red sand under the surface, and beds of "Kunkur," or nodule limestone, which provide an efficient drainage for the subsoil waters. 5th. The Sone river water is the surface drainage of the monsoon rains, south-west to the sources of the Nerbudda river, near Umur Kuntuk, the highest point of the Vindhia range, and so it happens that about the end of March the supply of water ceases, or at least decreases greatly, till the next rainy season, and full irrigation cannot be resumed before the beginning of July, so that the land has three months' rest, either in open or close fallow. 6th. There may also be a marked difference between the water from the drainage of the Sone valley, and that during the hot months from the melted snows of the Himalayas.

By the terms of the lease of the Judgespore estate, no improvements were stipulated for further than the clearing off 2,000 bighas of the jungle, and making that portion of the land fit for cultivation.

As this was being done, a good public road was constructed through the estate in the direction of its length, from the East Indian Railway at Beheea, south, to a village called Pero, on the road from Arrah to Sasseram, which is on the Grand Trunk Road. This new branch is shown on the map of the estate, and is eighteen miles long. Five hundred masonry wells were also made, many years before the canal works began, and these are now used for domestic purposes, and for the irrigation of green crops in the hot weather when the canals are dry. It should be here remarked that in this particular the Sone system of canals is unlike the Ganges and Jumna canals. The Sone watershed has no snowy range, such as the Himalayas, from whence a hot weather supply of water can be obtained by the melting of the snows. This I believe to be an advantage of great importance in favour of the Sone system, as it secures a rest to the land at a time when such rest can be of the greatest recuperative benefit, that is, during the three hot weather months, when the burning hot winds blow steadily down the Ganges valley from the west. The ryots know well the value of an open fallow in these months, and, for many crops, consider it equal to a manuring. Doubtless, the atmosphere at that time is rich in the elements that nourish and sustain vegetable life; and especially so in June and July, when the descending rain carries these elements into the bosom of the dry open land. Though knowing well the value of an open fallow, it was possible only to a very limited extent, while the water had to be lifted from wells, or occasional pools; but with canals the possibility is indefinitely extended, though as yet only partially taken advantage of. The practice will grow, because its value is well known, but at present the ryots have work enough for all their time, and available bullock power, in the great variety of simultaneous and successive crops. This variety of crop was within their power before the canals opened, but results being so very uncertain, the cultivation was half-hearted and fitful. Under the new and reliable conditions, the routine will gradually be adapted in practice to suit them, and an open fallow will be as essential as a patch of sugar cane in their system of rotation of crops.

Though in great need of improvement and invention, the natives of India seem to have no originality; the faculty may exist, but, if so, it is not developed. This may be owing to several causes—a tropical or subtropical climate; the necessaries of life being few, and obtainable with comparative ease; the variety of the products of the soil being amply sufficient and to spare for the gratification of ordinary wants, and also for the elegancies of life as understood by them; the minute, yet well defined, divisions of their social system, and its unquestioned acceptance by all of whatever grade; the jealous independence of family groups, or individuals even, of the same caste, thus rendering combination for improvement or other purposes difficult. All these peculiarities are intensified by a reverence for the past, and a suspicion of change. Thus, their implements are of the rudest construction, and adapted only for family or domestic use; and, with their methods of agriculture and manufacture, have reference to a time in the far past, when India had not yet been obliged to enter the lists of competition with other countries, and with more advanced and versatile peoples. The fraction of weavers that yet remain scattered here and there, in distant villages, is fast disappearing before the bales of piece goods which find their way into every bazaar, as improved roads are extended.

In addition to that used in the country, the export of oil seeds in 1879 was 7,211 cwts. (*vide* Statistical Abstract for 1879). This means a loss of cattle food of 4,400,000 cwts. of oil-cake, which the normal condition of their work-cattle can ill spare. A fair allowance of oil-cake may be stated at 4 lbs. per head per day. Thus, a valuable article of food for 337,534 cattle for twelve months, is lost where it is most wanted. As this reduces the stamina of the cattle, the quality of cultivation is in proportion deteriorated, and as each pair of bullocks cultivate about 10 biggas (6¼ acres), this will be felt over 1,054,000 acres, or 1,650 square miles The people themselves have frequently a difficulty in obtaining the oil they require. Yet oil mills on the European plan do not succeed, they are too centralised, too much in one place; for the people and their cattle the seed must be crushed where it is grown. The native oil mill has long been unequal to this duty, and is daily becoming more so.

Sugar-cane is another high class product, in which an enormous annual loss is suffered by the people of India, owing to barbarous and irrational methods of cultivation extraction, and preparation of juice for the market. Whatever may have been the previous crop on the land to be planted with sugar-cane—in Shahabad it is usually a pea crop—it receives about a dozen ploughings at intervals. During such intervals, any manure that may be available is spread over it, and in February and March the land is ready for receiving the cane cuttings. Cane cuttings 6 in. to 8 in. long, in the proportion of 1,800 per acre have previously been provided, and placed in a pit amongst wood ashes (which prevents the attacks of white ants) and other manure, and then covered over with straw and earth. In this pit the cuttings heat and germinate more readily. A plough-furrow is traced round the outer edge of the field, and continued in a spiral form till the centre of the field is reached. These spirals are about nine inches apart. A person of either sex follows each plough, dropping the already germinated cuttings at about 18 inches apart. A plank, or piece of wood 10 to 15 feet long, is then drawn over the field by one or two pairs of bullocks, according to its length and weight, with one or two men standing on it, to give additional weight, as well as to drive the bullocks, The men steady themselves by holding the tails of the bullocks, and guide the animals at the same time. The field is thus rolled, and the cuttings covered up about four inches below the surface. In about ten or twelve days the field is freely irrigated, and, as the plants rise and the ground dries and hardens, it is dug over and irrigated several times till the young leaves give it a partial shade. As the shade increases by the growth of the leaves, digging is not continued, but occasional waterings are given, the lower withered leaves being allowed to remain on the stools till the field gradually becomes a thick impenetrable jungle mass. The evils of this system are—1st. The gradual hardening of the soil round the tender fibrous rootlets of the cane, preventing their free action; 2nd. The closing out of both light and air by the mass of dry leaves which it is considered necessary to retain for the proper secretion of the saccharine juices of the canes; 3rd. The impossibility of getting at the ground to loosen its surface, and give the imprisoned rootlets their natural freedom and necessary supply of air; 4th. The increasing hardening and souring of the land by each successive watering; 5th. Placing the cuttings so near the surface at that time of the year when the sky becomes a dome of brass, and hot winds absorb every particle of moisture, and when only a minimum supply of water is available from canal, well, or reservoir; 6th. Owing to the haphazard way in which manure is used for a cane crop, and uncertainty as to the exact extent and localities of the future cane plants, it is, at most, an even chance if the little manure available will be in contact with or near the roots.

In sugar-producing colonies and countries, where cane is cultivated in a scientific manner, that is, in accordance with its nature, it is put down in rows at least four feet apart, and as the plant has not a tap root, but only a bunch or ball of fibrous rootlets with which to supply the large demand of the cane and its long broad leaves with the necessary quantity of juice, care is taken that by means of either hoe or plough, the cutting or germ be laid at least eight or nine inches beneath the line of the surface. The cuttings are only lightly covered at first, but, as the plant grows, the hollow becomes a ridge of loose friable mould, in which the roots have liberty to expand with the necessary supply of air to work out their natural functions. If irrigation be necessary, it reaches the roots laterally from between the rows. If drainage be required, the water is drawn off by these spaces, while the soil of the ridge remains free and soft. Dead and withered leaves are removed to give light and air, and weeding and hoeing are comparatively easy. Manure is applied, but only where the roots are to be, before or when the cuttings are put down, and also afterwards where necessary, as the plant rises above ground, and as the ridges are formed up. Sugar-cane requires and will pay for a careful "garden" cultivation, in accordance with the nature of the plant and conditions of soil and climate. In India these essentials receive no consideration. Cane for sugar making seldom exceeds four or five feet in length, and is thin and hard, as might be expected from the unequal struggle it has for life. We have experimentally cultivated some of the same kind of cane by the rational methods just referred to above, to the satisfaction of ourselves and the surprise of our ryots; the canes so grown being 8 feet long, and they doubt if it is the same kind as is grown by themselves. Our endeavour has been, and is, to get them to adopt this method of culture. When the results of such cultivation are experienced by a few of them, it will slowly spread, because through it there is a greater economy in land, manure, and water, accompanied by an equal, if not greater, weight of cane from the same area, and as the plant receives the treatment its nature requires, a better quality of sugar will be obtained.

The following reasons may account for the origin and retention of these irrational and wasteful methods in cultivating, and subsequent treatment of a most valuable crop. Old men have told us they remember the time when "goor," or "jaggery" (sugar as they make it) was worth only its weight in rice, its proper cultivation would therefore be of only minor importance, and only enough cane would be grown, in a rough-and-ready way, for the supply of family wants.

The opening of railways into the interior, giving the cheap and rapid transit, necessary for such a crude and perishable product as "jaggery," gradually increased its value, and, consequently, also the area under cane; and in this matter, as in others, the retarding and deadening effects of ages of inherited custom, superstitiously observed, has stood between them and the possibility of spontaneous improvement.

It is difficult, if not impossible, to form a definite idea of the enormous extent and value of the sugar industry of India, or of the annual waste and loss sustained by the cultivators through ignorance, that their methods are unsuitable, and therefore vicious, and that cleanliness is of the first importance.

The map of cane areas in the North-West Provinces and Oude, prepared by Mr. Buck, C.S., Director of Agriculture and Commerce, gives the per-centage of the area under cane in the various districts as averaging from one to eight per cent. The census returns of 1871-2 give the area of the sub-Himalayan portion of the North-West Provinces as 69,903 square miles, and of Oude as 23,992 square miles, or together, a total of 93,895 square miles. The report of the Assistant Director of Agriculture and Commerce states (see North-West Provinces Circular, No. 8, of 7th July, 1880) the area under cane in the North-West Provinces and Oude to be 1,067,000 acres—1,668 square miles, or about 1·75 per cent. of the whole area. This includes an increase since 1876-7 of 160,000 acres, or 250 square miles, which is only 0·26 per cent. of the total area.

We estimate the maximum average produce of raw sugar (goor or jaggery) to be about 30 cwt. per acre, which makes the total yearly production over the above area to 32,000,000 cwts., which at 7s. 3½d. per cwt. equals £11,666,000. By being doubled, the area under cane would be only 3½ per cent. of the total area, and at the rate of increase between 1877 to 1880, above alluded to, this may be done in 25 years.

The census of 1871-2 gives the area of Bengal with Behar as 157,598 square miles. The area under cane cultivation "has been roughly estimated at 1,400,000 acres," or 2,287 square miles, that is, only 1·38 per cent. of the whole area.

Assuming the out-turn from this area to be at the rate of 30 cwt. of "goor" per acre, and the value at 7s. 3½d. per cwt., we have 42 million cwt. of raw sugar produced annually, worth £15,312,000; here also, if the area under cane were doubled, it would be only 2·76 per cent of the total area.

The proportion of population to cane area in the North-West Provinces and Oude is 2·60 per cent. of 41 millions of people, producing 87 lbs. of raw sugar per head of the population; and in Bengal and Behar, 2·31 per cent. of 60,467,724 people produce 77 lbs. per head of the population. Thus the population of Bengal and Behar, the North-West Provinces and Oude, numbering, by the census of 1871-2, 101,467,724, produce 74 million cwts. of sugar, or about 81 lbs. per head, which is very much in excess of the local consumption. The population of British India, including native States and foreign possessions is, according to the Statistical Abstract, 1878-9 (p. 6), 241,182,052, leaving a balance, after deducting the population above noted of Bengal, &c., of 139,714,328 of a sugar-eating population to be provided for; but the cane districts of the Gangetic valley do not represent all the sugar-producing areas of India. The Punjab, Madras, Bombay, Burma, and the native States produce sugar in quantities of which it is difficult to get reliable figures, but suppose it is half as much as that of the Gangetic valley, the total would be 111 million cwts., or 51 lbs. per head of the population.

The exports are comparatively small, only 368,546 cwts. in 1879, while the imports were 923,381 cwts. It thus appears that India is producing sugar for home consumption only, and at the rate of 51 lbs. per head of population. (This does not include the produce of the date palm, which is considerable in some parts of India.) To those acquainted with the habits of the agricultural and labouring classes of India, this will appear more than a liberal allowance for consumption. (In 1880, the consumption per head of the population of the United Kingdom was about 63½ lbs.) It is evident the production could be easily doubled, without making an undue and disproportionate demand on the supply of labour and land. Any increase in the area under cane, will tend to reduce the present low prices, if it be greater than a proportionate increase of the population. Profitable extension, then, is only possible when the cultivation of the cane, and manufacture of the raw sugar, has been so far improved as to bear export by sea, or long journeys by land, exposed to changes of weather and temperature.

The "Colonial Statistical Abstract" for 1879 gives the total production of sugar by Jamaica, Barbadoes, Trinidad, British Guiana, and Mauritius, as 6,870,725 cwts., valued at £6,967,128, being an average of 20s. 3¼d per cwt.

It may be here mentioned that there is a large bi-weekly bazaar or market at our chief village, Jugdespore, and a register of prices is kept up at the zamindary office there. Taking an average of five years (the "goor," or "jaggery," being of the improved quality produced by the Beheea cane mill), the value is only about 7s. 3½d. per cwt., or a little more than one-third in value, as compared with colonial sugars. The total Indian production, 111 million cwt., if of equal quality to the sugars produced in the West Indies and Mauritius, would be worth 126 millions sterling, but it appears the Indian cultivators get only about 40½ millions for it.

It is not to be expected that the necessarily domestic nature of the sugar industry of India can ever be improved to equal in quality of produce, the careful scientific manufacture of the large sugar estates in the colonies above referred to, with their costly machinery and all recent improvements. The difference is 85½ millions, and it may reasonably be hoped to recover one-fourth of this, which would amount to an additional 22½ millions sterling—a vast advantage to India, especially were this sum the equivalent of sugar exported. There seems to be no reason in soil, climate, time, or value, and supply of labour why this advantage should not be recovered.

The first necessity is a careful "garden" cultivation of the sugar-cane plant in harmony with its nature and habits, instead of the present rude field cultivation; secondly, improved means of extracting the cane juice; thirdly, the proper treatment of the juice after extraction, by cleansing and fumigation of receiving vessels, straining and removal of foreign matter, defecation and evaporation of the watery portion of the juice at the lowest possible temperature, all of which essentials are obtainable by means within the reach of the people. These remedies are within the means of the smallest cultivator, but he is only an atom in the huge mass of the Indian ryots. Were he to step out of the rut to produce a better article, no one would give him a corresponding price for it. This is one reason why the acceptance of the Beheea Mill, to be presently alluded to, was so gradual and hesitating; and it was only as a means of saving labour, and not as producing a better quality of sugar, which carried it through the initial stages, till the improved sugar appeared in the bazaars in sufficient quantity to command a distinct recognition and name of its own, when it began to be inquired for at higher prices. The difference between the "Kolhu" goor and the usual Beheea Mill goor will be seen by a comparison of samples 1 and 2; and between the latter and that from mill juice strained and received into porous earthen vessels, thoroughly washed and fumigated, then carefully defecated and the scum removed, by comparing samples 2 and 3. Having shown our tenants how easy and simple it is to secure a better quality by cleanliness, they admit the fact, but object that there is no demand for the improved quality at a price which would pay them for the extra trouble and loss of weight involved. It seems evident, therefore, that the mass of the ryots must be leavened or moved by some external influence, that is, means must be found of producing a better quality of sugar at or about the price of the inferior quality, at least, for a time (we have this in view for our own neighbourhood), and by methods within reach of the smallest cultivator. The profits realised by them, even at present prices, will admit of this being done, and if the quality is improved to the point of bearing changes of temperature and humidity during sea or land transit, the low cost of production would enable them to compete successfully in the markets of Europe and the colonies. What they now produce at a fair profit, is less than half the average value of colonial sugars; there is thus ample room for improvement and hope in the future.

The want of combination and mutual trust keeps the manufacture of sugar from the cane in a domestic form for the present, and consequently, prevents the cultivators taking advantage of improvements in the crushing of cane and evaporation of juice by costly and complicated appliances. The indigenous cane mills of India are of various forms, generally made of wood, and in a few localities of stone. All over Bengal, Behar, the North-West Provinces, Oude, the Punjab, and other parts of India, with no exceptions that we know of, the cane is cut into lengths, varying from a couple of inches to three feet. The numerous sections thus exposed to the air begin to ferment. The shorter pieces are crushed and triturated in a mill, such as Nos. 1 and 2, and fermentation increases by contact with the active yeast adhering to the inside of the wooden mill. Pieces of 18 inches and upwards are passed four or five times between rudely made wooden rollers, to which ferment is also adhering. As a rule, the porous earthen vessels placed to receive the juice are never washed or fumigated, and are consequently lined and saturated with ferment also, nor is the juice strained or defecated, to free it from or counteract these active agents of fermentation; added to all these drawbacks, the time required to get enough juice for one boiling reduces the granulating quality of the juice to a minimum, if, indeed, it is not entirely destroyed, as frequently is the case. The writer met with a characteristic instance of this when visiting a distant part of the country, up the valley of the Sone. Being acquainted with the ryots, he went into their sugar-making sheds, during the cane-crushing season, to see the quality of the out-turn, and in one place observed that there was literally no grain, but lumps of hardened treacle instead. The owner gave as a reason of this, that his mill was under the spell of a certain "Dyne," or witch whom he knew, and that he would at once employ an "Ojha," or exorciser, to remove the spell. His cane was lying in a heap, cut up into lengths of two and three inches, and he said it had been in that state a couple of days. He was told that the poor suspected woman was not to blame, consequently he need not spend money in bringing an "Ojha," as he could not help him. He had kept his cuttings till the juice in them was spoiled by ferment in themselves, and in unwashed vessels, and that if he liked, a small iron roll mill would be sent to him, which would crush whole canes quickly, and over which neither "Dyne" nor "Ojha" had any power. His look and reply, of course, betokened incredulity, but his subsequent experience was too strong for the prevailing and vicious superstition which till then had held him.

No. 3 is a half-size model of these improved mills. They weigh about 400 lbs., and are easily portable on two bamboos, or poles, by four men. The machine is therefore a toy, and insignificant, judged by European standards of such machinery. Its introduction was very gradual, and its acceptance hesitating and cautious, by a conservative and suspicious people, even though the village priests could not say that the contact with iron affected the caste purity of the juice. The merchant, finding a better grain, offered from twelve to fifteen per cent. more for the iron mill sugar, when it began to appear in the bazaars in quantities. Repairs and breakages in the mills being arranged for, the demand for them increased year by year—from tens to fifties, from that to hundreds—and now it has reached thousands. Some twenty thousand have been at work this season, the property of as many families; for in the cane-growing districts it is the ambition of the head of a family to possess a Beheea cane mill, as it is found that the advantage per cane season of 90 days, in labour and time saved, and in the increased value of the produce, amounts in value to about 327 rupees per mill; and as the machine costs only 85, 90, or 100 rupees, according to size, and, with fair usage, lasts 6 or 7 years, the investment is a good one.

The yearly addition to the wealth of these 20,000 families is thus 6,340,000 rupees (£634,000), obtained by a slight improvement in the working off of 140,000 acres of cane. Each mill is equal to squeezing per season a minimum of 7 acres; but the above is not a tithe of the enormous cane areas of India, nor is the saving a tithe of the annual loss so suffered by the people, owing to irrational and obsolete methods.

In addition to these advantages of the Beheea mill, the cane crop is worked off most expeditiously, and enables the ryots to stop crushing for a time, should prices for sugar be low, and await the chances of a better market, without detriment to the crop. They have also much more time to attend to other necessary agricultural operations, all of which it is impossible to do when depending on the native cane mills; sometimes, indeed, a portion of the cane crop was burned where it stood, or sold for elephants' or cattle food, because the native mill was unequal to the task of working it off before the season was over.

Irrespective of the responsibilities of material progress and improvement, the Government of India has been entrusted with the guidance of a series of changes of unusual importance, radically affecting the masses; changes, the result of methods and influences in a great measure foreign to them. The peoples of India, in their hundreds of millions, are being detached from the conditions and influences of the past, while uncertain and powerless as to the future, socially or politically. The genius of the West, with which they have been brought into contact, as opposed to that of the East, tends to the recognition and development of the individual as the basis of social life. Caste is gradually ceasing to be a source of advantage, and the inconvenience of its limitations and peculiar observances increases in consequence. Caste names tend more than formerly to indicate the individual, and not the class, tribe, or division of such to which he may belong. So it is with the village community. That social edifice, having its foundations deep in past centuries, and maintained by the sanctions of a hoary theology, giving practical form to an artificial selection, and preference of some classes at the cost of a permanent degradation of other classes, must fall to the ground in the presence of a system which rests on and endeavours to work out the higher law, that is the right of the individual to his own disposal, and the duty of society to recognise that right.

There is a living intelligent force at work, which the Government of India, in its more superficial action, can best utilise by its recognition, and the removal of temporary obstructions as they arise, leaving the future at liberty to develope itself, without the brand of prejudice, party, or class feeling or influence. India has lain prostrate under a system by which the rights of all as individuals have been sacrificed to the maintenance of an aristocracy, whose exclusive and unnatural position has rendered it effete and useless for purposes of social weal or progress. In many ways it is evident the Government of India, in India, recognises its duty in this direction, that is to rule as the representative of the people.

India being essentially an agricultural country, the holdings small, and the cultivations numerous and varied, the interests claiming recognition and consideration are much beyond the grasp of a private individual, whose experience has been only local and limited. Those interested in the land tenures of India can get information worthy of the subject in a series of papers by the chairman, Sir George Campbell, which have been published by Messrs. Cassell, Petter, Galpin, and Co.

DISCUSSION.

The Chairman said Mr. Mylne was a practical instance of the good which might be done in India by an energetic man who carried with him the energetic qualities of an Englishman, or rather of a Scotchman, which, perhaps, was still better. Working with a sound heart and a sound mind amongst the native community, he had obtained their co-operation and attachment, and had in that way been able to do an immense amount of good to those amongst whom he lived. If he had done nothing else but introduce the improved sugar mill, that was a great work accomplished, and a great proof of what might be done. They were often told that these people were too conservative, and not willing to adopt improvements; but there were many instances in which they had refused to do so, because they knew more of their own soil and climate than some of those who attempted to teach them. Practical experience had shown, as in this case, that when something was put before them which was really practically useful, which increased their produce and means of sustaining their families, they were not averse to adopting it, but on the contrary, having learnt the advantage of anything new introduced among them, they were as ready to appreciate it as any cultivators in Europe. They had heard that now many thousands of these mills were being used, and that might be termed quite a revolution in the sugar cultivation. He only wished that there were many more men possessing the same practical talents and influence, but he feared they could not expect to have such men everywhere. He could quite understand the view Mr. Mylne took, looking to the advantages gained by the administration of this estate, that the great want of India was the interposition of a class of zamindars between the Government and the people, but he was not prepared to go quite as far as that. Mr. Mylne had himself told them that a large proportion of the zamindars had not fulfilled the functions of landlords, but were rather drones and cumberers of the soil. He was inclined to think that they should not have too level a uniformity, but considerable variety. We were now very much inclined to believe in the advantages of a system of peasant proprietors, and in a neighbouring island something was being done to establish a system of that kind. That system was widely spread in India, and he thought it had many advantages. On the other hand, it was most desirable not to have absolute uniformity, when they could have such men as Mr. Mylne as land owners, who would set an example of progress and improved cultivation, and so benefit both themselves and their neighbours. Mr. Mylne, energetic as he was, was inclined to think that the time had come when village communities should be dissolved, and they should trust rather to the energies of individuals. In that respect, it seemed to him that in this country there had been some reaction of opinion, and great as were the advantages of individual energy, there was something to be gained by local government, and the assistance of people in small communities attempting to govern themselves, without too much interference by the central power. He must say that he hoped the day was far distant when a system which had come down from so many thousand years, should be dissolved. We had a great task before us in governing India, and might be very well satisfied to delegate a portion of that task to local self-governing bodies.

Sir William Robinson said that his experience had happily lain in a non-zamindari Presidency, and all his judgment was against the zamindari system, as it affected the interests and political and social rights and condition of the agricultural population throughout India. He had to remark with regard to the zamindari in question, that while it is quite possible that the immediate area of country, under the management of Mr. Mylne and his partners, had benefited materially by what had taken place, he held firmly, at the same time, that a precedent and example had been set up in this instance—possibly to be perpetuated under the contract—such as he should wish to see followed in any part of India. No doubt there were great advantages in getting some outlying hilly and wild parts of India under European management, and made the object of their commercial enterprise. But here you had a vast area of country—in a backward condition it is true, because of a bad zamindari, and temporarily disorganised by rebellion—lying within a rich district, with no lack of agricultural inhabitants (the zamindari was itself well peopled in parts) reconsigned to zamindari tenure, and that under aliens. The estate had escheated to the Government, and an opportunity was afforded of recognising and securing the rights of the native peasant proprietors and occupiers of the land, and restoring to them what they had been deprived of by the zamindar system imposed on the country by the British rule. But the opportunity was apparently lost. He knew nothing about this particular case, except what appeared from the paper. The first settlement with Khoer Sing was probably right, on the whole, under the principles which guided the early zamindari settlement of Bengal. We apparently found a robber chieftain who had subdued the wide area under consideration; usurped the rights of the agricultural inhabitants whom he oppressed, as was the case with nearly all robber chieftains who, under like circumstances, became feudal zamindars under the British rule. The settlement was, no doubt, moderate, so far as the State demand was concerned, thereby depriving the Government of fair increment of revenue; but mismanagement, and at length, rebellion, secured a clear escheat of the property to the Government. In replacing the zamindars of the country by European speculators and contractors from Calcutta, he believed the Government had been led into a gross political error, and done social and national wrong. The thing could not have occurred, he was thankful to say, in Madras. There permanent settlement was forced upon a very reluctant administration, and it was carried out by statesmen of remarkably high intelligence, well acquainted with the relative rights and claims of the agricultural community, and thoroughly appreciative of the spirit of native institutions; for Sir Thomas Munro guided more or less the deliberations of that day. The zamindari system, so far as it applied to Madras, was carried out in a comparatively efficient manner. The Commission of inquiry into the assets of each estate extended that inquiry to the condition of the holdings (village or individual) of the peasant proprietary (ryots) of each estate, and the customary demands upon them. These were duly recorded, and the zamindari demand was based on a fair proportion of this aggregate; while the information then registered has practically extended the moderate spirit and security of tenure intended by the settlement, to the cultivating and ancient peasant proprietary also, and constitutes no mean protection against exorbitant increase of demand and eviction in most parts of the country. The zamindari demand, so assessed in the interest of the State, was so high that it could only be persistently met under good management, such as was very generally wanting; and, wherever, in the course of the next 50 years, an estate has failed, the opportunity was taken to relieve the country and to restore to the peasant proprietary their suspended or imperilled rights—in other words, to make a ryot-wari settlement in supercession of bankrupt system that had intervened. If such a case as that before the meeting had occurred in Madras, an escheat of this kind would have been taken advantage of to restore the people their rights, and to suppress the enforced zamindar system, and its bad landlordism. Of course, he did not apply that term to Mr. Mylne, but, taking zamindars as a whole, they have proved a little creditable class of landlords. He made this observation on principle; because he thought that even bright exceptions ought not to be too readily accepted by the meeting, although he should hope that the Government of India had already come to such a general sense of the rights of the peasant proprietary, and of the native community there, as not to make a mistake of this kind in any part of India again. He had no doubt that all that was stated here of the Jugdespore zamindars was perfectly true, that alien proprietors, though they be, who had been placed in charge of this estate, they were doing their duty, and had done it; and that they were really of benefit to the district. At the same time, he thoroughly objected to such transactions on principle. The lease, apparently, was perpetual; the country had advanced in a marvellous way, and what had been justly alluded to as the unearned increment, must be very large and profitable to the zamindar. There were no statistics to show what the improvement had been in that respect, but he had no doubt the concern had proved a valuable speculation. Mr. Mylne said that in Madras the Government stood in the position of a zamindar, or landlord. Such is not the case. The ryot-wari landholders are the landlords and proprietors of Madras; and they had done their duty by the country very well indeed. Only within the last 25 years they had nearly doubled the area of culivation; on the other hand, too, the Government had done its duty as a government and a capitalist, in advancing irrigation and material improvement. But it neither stood in the position of proprietor, nor did it carry out the duties of landlord. Nothing was more to be deprecated than to place the State in the position of landlord in any country in the world, least of all, India. They saw, in a neighbouring island, what a difficult position landlords had to fulfil, and he should be sorry to see the theory accepted that the Government of India held that position, or was responsible for its duties. Mr. Mylne went through the question of the administration of the land laws in India, with respect to the collection of rent and arrears, but he was not quite accurate in his history; certainly not as regards Madras, when he said the strict law of hypothec, &c., which is enforced by zamindars in Bengal, is an ancient Oriental institution. Anyone who knows aught of the discussion which took place on the passing of the Zamindari Acts, should know that those provisions were derived more or less from the spirit of the Scotch law, and he could in no way endorse this zamindar's favourable picture of their operation, or fears in regard to their modification, now properly in contemplation. Mr. Mylne said that a large number of his tenants occupied at permanent rents, which, of course, was a very valuable concession, and he believed that system was now becoming more or less extended throughout Bengal. The object of the Act of 1859 was to fix the tenures of the great mass of subordinate tenures within zamindar estates, and he was glad to see that it was likely to be largely extended. He did not wonder at a zamindar like Mr. Mylne crying out against any alteration of the law which was directed towards the protection of the ryots, but he trusted that his views on these matters would not be permitted to carry any weight with the Government. Even in Madras, the ryots wanted similar protection; and the fact that the powerful European zamindars were placed in a position to question the benevolent intentions of the Government in that direction was, he considered, a serious embarrassment. He was very glad to think that there were not many of them, because an European outcry on these matters seemed, in India, to carry more weight than it ought to.

Dr. MOUAT said he did not pretend to any intimate knowledge of the land laws of India, especially in Madras, and of course, could not question what Sir William Robinson had said, but he would content himself with reading the views of the Government of Bengal and of India on this question, and then leave the audience to infer how far it deserved to be characterised as a political error and a social wrong. In February last, on Mr. Burrows applying for a renewal of his lease, the following was the letter addressed to the Government of India :—

Extracts from a letter of the Officiating Secretary, Government of Bengal, to the Government of India, in the Revenue and Agricultural Department, dated 7th January, 1882 :—

"5. Mr. Burrows and his partners, Messrs. Thomson and Mylne, who have assisted him from the beginning of the undertaking, have now held the Jugdespore Estate for more than twenty years, and have laid out a considerable amount of capital in carrying into effect various schemes of improvement, with marked success. The Lieutenant-Governor has personally visited the estate, and from what he has himself seen, and from the reports which have, from time to time, reached him on the subject, he considers Messrs. Burrows, Thomson, and Mylne the best landlords with whom he has yet become acquainted in India. The estate is a model of all that an estate of the kind ought to be. Besides the introduction of an industrious and thrifty tenantry on tha estate, and the inauguration among them of various improved methods of agriculture and manufacture, the lessees have constructed extensive lines of roads and canals, besides numerous bridges, wells, and other works of public utility, such as schools and dispensaries. Personally, Sir Ashley Eden is convinced that the estate could not be placed in better hands than theirs."

* * * * *

"9. Messrs. Burrows, Thomson, and Mylne have converted the wild forest of Jugdespore into a garden, and their beneficial influence as landlords, and introducers of agricultural improvements, has been felt throughout the whole district of Shahabad, and, indeed, has spread into the surrounding districts."

He was perfectly satisfied from what he had seen of this jungle that it could by no possibility have been placed in worse hands than to be dealt with in the manner recommended by Sir William Robinson. He would now read the opinions of the Government of India on this qustion :—

Extract from letter of the Officiating Secretary, Government of India, to the Secretary, Government of Bengal, Revenue Department :—

"3. The Government of India approves the proposals as stated in paragraph eight of your letter under reply, and is glad to be assured that the enterprise and wise liberality displayed by the lessees in the management of their estate have been crowned with so much success."

What greater proof could be afforded of the beneficial result of European knowledge, capital, enterprise, and a strong sense of justice towards individuals, than the result of establishing such men as his friends Messrs. Burrows, Thomson, and Mylne in the position of landlords in that country? There was no doubt they would not become the permanent proprietors of those estates, because as time went on, and they realised their fortunes, they would retire, and come back to England; but still he held that it was an incalculable advantage to India to bring such influences as these to bear upon the people, and Mr. Mylne had shown in a very striking way how it was possible to get at the very actual opinions of the people themselves. He was sorry to differ in any way from the opinion of Sir William Robinson, but nothing could induce him to regard this grant as a political error or social crime.

Mr. MARTIN WOOD said there was one brief reply even to Dr. Mouat's strongly expressed opinion. Admitting all that was said in those official statements, and in the paper itself, as to the immense benefits conferred on this particular part of Behar, which was on the line of railway within easy communication with the rest of Bengal and the markets, it might yet be urged that this was an exceptional instance, and that it by no means proved the rule, that the zamindari system was the best for India, or even for Behar. To go back a little, the case of Koer Sing was a most striking instance of the blind proceeding which was involved in the original permanent settlement, and showed the utter uselessness of the zamindari system as such,. No doubt, under a different system, the country would have been cultivated to a much larger extent. Mr. Mylne said one of the great wants of India was a body of zamindars with intelligence, capital, and public sentiment between the state and the mass of the cultivators. On the other hand, he (Mr. Wood) might say that India's great want was to have the ryots levelled up. This was *a propos* of the practical part of Mr. Mylne's paper, which gave the interesting history as to what had been done, and might be done by the methods he had described. It occurred to him that, as a practical result of this discussion, it would be very useful if the portion of the paper describing the improved sugar mills were translated into half-a-dozen vernaculars, and scattered right and left through the Punjab and Guzerat, where the sugar cultivation was largely carried on. But in common with Sir William Robinson, he should be very sorry if it went abroad that any meeting of the Society was willing to accept the view of the zamindari system taken in the paper. In the presence of Sir George Campbell he would not go into this subject, which was full of difficulty, but he could not forget the large and important part their Chairman took in confirming Act X of 1859. Many perhaps did not know that law had now to be reformed, and there was an immense deal of trouble being taken about what was known as the Behar and Bengal Rent Law. On this point he might refer to an article in the *Calcutta Review* of January, 1881, which clearly pointed out how necessary it was that the ryots should have further protection afforded them. The Commissioners of that rent law had given a summary of what they intended to do by it, and he was glad to find that they were especially considering the interests of the cultivating classes, and endeavouring to afford protection against arbitrary increase of rent, and to secure them compensation for improvements. The opening portion of that summary read thus:—"In the interest of the cultivating class (they say) we have afforded protection from arbitrary and excessive enhancement of rents; we have defined the incidents of a right of occupancy, and have made it a valuable property in the hands of a careful tenant; we have provided reasonable instalments of rent, and secured the evidence of payment; we have restrained the harassment of honest tenants, when their landlords are co-parceners, and cannot agree; we have given the evicted tenant the crop on the ground sown by himself, and have allowed compensation for any improvements which he may have made; and, finally, we have endeavoured to raise the standard of comfort by allowing the ryot to build himself a comfortable habitation, and by giving him some share in the material progress of his country." He (Mr. Wood) was so much pleased with the practical part of the paper, that he thought it was almost a pity to go into the disputatious portion of it. He had already referred to the question of sugar cultivation, and the next most practical point was the vindication Mr. Mylne had given of irrigation. He was glad to see that he was not scared with the bugbear of *reh* effloresence. Whatever was done in India, it could never be wrong to preserve and increase the store of water. One incidental remark he must beg leave to contradict. He could not admit for a moment that Afghanistan was in any way geographically a portion of the Indian system; and if they went into ethnography, it would be further off still. So he trusted that no authorities responsible for the affairs of India would ever again go on wool-gathering beyond the Suleiman.

Mr. E. KIMBER said it appeared to him that the comparison made by Sir William Robinson between the two systems of Madras and Behar had not been quite satisfactorily thrashed out. Sir William stated that within the last twenty-five years the ryot system at Madras had gone on fairly well, and, in fact, he said, the produce had been doubled. Now, comparing that with what the paper told them, that the Government had reported that this jungle at Behar had been turned into a garden—and, if so, he supposed the produce had been that of a garden, which would be rather more than that of a farm; and inasmuch as the jungle produced nothing, the land upon which the jungle then existed must now produce what a garden would produce, which must be much more than double. Those were the only data which they had upon which to form an estimate upon the comparative results of these two systems. In judging of the ryot system on the one hand, and the zemindari system on the other, they must compare the whole results commercially, socially, and politically, and he was prepared to discuss the question from any of those points of view. It was an ordinary platitude that the object of any good government was to secure the greatest good to the greatest number; he supposed Sir William Robinson meant that they had done so in Madras, but he did not gather that from the facts. He should imagine, from the manner in which this Behar district had hitherto attracted capital, that it was the happier and wealthier district. All they heard from Sir William Robinson was that, during the last twenty-five years the produce had doubled, and the system had gone on fairly well. As the Chairman said, this opened out a very large question. Only that day he had been consulted as to the terms of a lease professed to be granted by a member of the House of Lords as to whether the tenant should not defy the imposition of some covenants, because they were handed down from almost feudal times. They need not look down on the natives of India as if they were inferior to ourselves in regard to land laws. It was not necessary to go much further than our own doors to find instances of great hardship. He thought the zamindari system had been proved by the paper to be a system which had attracted a far greater amount of capital than the ryot system, which was an immense advantage. In this district they had canals made, which must take a large amount of capital, and if it were said that it was State capital, he should reply that the State only guaranteed the capital, and it would not foster these undertakings, unless it knew that the district was such as would in time justify the expenditure.

Sir William Robinson said the irrigation system in Madras was more perfect than in any other part of India.

Mr. Kimber said it appeared to him evident from the paper that the zamindari system extracted more from the soil.

Mr. Martin Wood said the comparison which had been made was between the whole Presidency of Madras and one estate in Behar; if they took the result of the whole Presidency on the one hand, they must take the whole Bengal Presidency on the other, which might alter the result entirely.

The Chairman said he had hoped that the discussion would have been mainly directed to the methods of agricultural improvement, of which India stood so much in need, and he rather regretted that it had taken a somewhat heated form, and touched on subjects more nearly approaching to high politics, and he thought the meeting would be inclined to agree with him that all these extreme opinions must be a good deal modified. In Bengal there had been too great a tendency to foster the large land owner, and, in some cases, it might be said the speculator. On the other hand, Sir William Robinson was very unfortunate, he thought, in applying his observations to this particular case, because there would be a general concurrence of opinion, that in this instance, the good effects of the system had been really pre-eminent. Still it might be said that one swallow did not make a summer, and he knew no other instance in which a zamindar had conferred such great benefits on the country as those who had been described. He concluded by proposing a hearty vote of thanks to Mr. Mylne for his paper.

This was carried unanimously, and the meeting adjourned.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 10th, 1882; Edward Birkbeck, M.P., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Barker, Thomas, Beechlands, Aigburth, Liverpool; Llandudno, and Devonshire Club, St. James's, S.W.
Beor, E. J., Southern Bank, Aylestone-hill, Hereford.
Best, Alfred, "Freemasons' Tavern," Great Queen-street, W.C.
Collins, William James, 2, Gresham-buildings, Guildhall, E.C.
MacNamara, J. Moore, 46, Great College-street, Brighton.
Shillito, H. S., Hatfield-park, Herts.
Terry, James, 4, Freemasons'-hall, Great Queen-street, W.C.

The following candidates were balloted for and duly elected members of the Society:—

Arnold, David Nelson, Bickenhill-hall, near Birmingham.
Bradbear, W., 23, Finsbury-circus, E.C.
Brown, David, F.C.S., 93, Abbey-hill, Edinburgh.
Bury, William, 5, New London-street, E.C.
Kenrick, George Hamilton, Church-road, Edgbaston, Birmingham.
Layborn, Daniel, Dutton-street, Liverpool.
Shaw, C. J., Clifton-house, Gascoigne-rd., Hackney, E.
Watkin, Alfred Mellor, Dunedin-house, Folkestone.
Wilson, John Millar, F.C.S., Birch Vale, Derbyshire.

The paper read was—

THE FISH SUPPLY OF LONDON.

By Spencer Walpole

(late H.M. Inspector of Fisheries).

When I was first invited, some months ago, to read a paper this evening on the "Fish Supply of London," I confess that I was extremely reluctant to do so. The subject seemed to me so vast, it was divided into so many branches, and was connected with so much controversy, that I despaired of doing adequate justice to it within any reasonable compass. But as time wore on, and I noticed the interest which the subject was exciting—when I perceived that opinions were expressed which I believed to be wholly erroneous, I thought that I was bound to reconsider my decision: for I felt that in the position which I occupied, if I had any information to impart, I was hardly justified in withholding it. But though I consequently reconsidered the conclusion which I had originally formed, I in no way altered the opinion which I had formed of the extreme difficulty of fulfilling this duty. In fact, the more I have considered the subject, the more difficult does it seem to me to deal with it adequately. If I avoid detail, I am afraid you will think me superficial; while, if I enter into detail, I am afraid I must necessarily be dull.

Now, in the first place, I should like to ask you to consider what is meant by the fish supply of London. In its literal sense, the term, of course, means the supply of fish to a metropolis which includes some four millions of people. But vast as the subject is when it is presented in this form, it becomes much more vast if you really consider it in its whole bearings. The central market in London is not merely the source of supply for the metropolis alone; the whole of the home and most of the southern counties of this country are supplied with fish from Billingsgate. I venture to say that if any of you on the next excursion you make to any of the great southern watering places of this kingdom, happen to ask where the fish comes from, you will be told that it comes from Billingsgate. In fact, the position of these towns reminds me of a story which, probably, many of you have heard—of the Englishman who was fond of Portugal onions, and who took advantage of a visit to Lisbon to obtain the genuine article. Do you recollect what the Portuguese tradesman said to him when he asked for some onion seed? He said, "I am quite sure you will find this seed good, for it comes from a place in London, which they call Covent-garden." In precisely the same way, if you go down to Brighton, and ask for some Brighton slips, you may be quite sure they will be good, for they will have come from a place in London which they call Billingsgate. But it is not merely the home and southern counties which are dependent on Billingsgate for their supply of fish. I was staying, myself, a few weeks ago, with some relatives of mine, in northern Lancashire, and the excellent dish of fish which they gave me for dinner, I found on inquiry came from Mr. Charles, in Arabella-row. But I can tell you a still more surprising story. It was my duty two years ago to visit the great Fishery Exhibition, held at Berlin. The President of the Exhibition, who is Chairman of the Deutsch Fischerei Verein, was good enough to ask me to luncheon; he gave me at luncheon a sole; I knew the interest which the German fisheries were exciting in Germany; I knew the efforts which the German Government was making to promote their fisheries; and I said to Herr von Behz, my host, let us ascertain where this sole was caught. He asked the waiter, who said, "This sole, sir, came from London." Therefore, when we talk of the fish supply of London, the subject is inseparably connected with the supply, not merely of many counties in this country, but of many foreign countries. Now if I have made this plain to you, at the outset, I should like to try and explain to you what the present supply is to meet this great demand. I believe I am right in saying that in 1880, which is the last year for which I have any returns, rather more than 130,000 tons of fish came to London. Now, I know that vast figures of this kind make a very faint impression on most people. I recollect that my late colleague, poor Mr. Frank Buckland—whose name I cannot mention without regret, and whose name you also will not hear without respect—used to say that he thanked Providence that he had ten fingers on his two hands, because it enabled him, at any rate, to realise the number "ten." With a recollection of his difficulty, I will try to translate the 130,000 tons of fish into some more intelligible term. One hundred and thirty-thousand tons of fish a-year, I may remind you, means a supply of 400 tons of fish, or thereabouts, on every working day in each week throughout the year, and 400 tons of fish, I believe, are equal—I am rather relying now on the authority of the Chairman—to a drove of 1,000 oxen entering London. In weight, therefore, the fishermen of this country are contributing as much food to London as if they drove 1,000 oxen into the streets every week day in the year. That strikes me as a very remarkable fact; but what I wish especially to point out to you is that, vast as this supply is, it is steadily increasing. I have jotted down some figures here, and I find that the increase has been in the last five years from 95,000 tons to 130,000 tons. Now, in the same period the population of this metropolis has probably increased about 6 per cent. The supply of fish increased by more than 35 per cent. Therefore the supply of fish, notwithstanding all the many difficulties with which we are acquainted, and which I for one do not wish to underrate, is increasing six times more rapidly than the population of the metropolis.

Now, there is another subject connected with the supply on which you will, perhaps, pardon my entering at some little length. I wish to point out to you where this supply is drawn from. I was very much impressed the other day by a speech which was made at the Mansion-house by my colleague. I am afraid I have no right to call him my colleague—but by my friend Mr. Huxley. Mr. Huxley said that the North Atlantic Ocean was richer, both in quantity and quality, than any other portion of the globe in edible fish; and that that part of the North Atlantic Ocean which was richest was precisely that portion of it which surrounded these fortunate islands. I believe that I should be accurate if I refined even a little further, and said, that that portion of the North Atlantic Ocean which is richest in edible fish, and which surrounds these islands, is that portion of it which we commonly know as the North Sea. Now you are all acquainted, at any rate upon the maps, with the North Sea. You know that it is comparatively a small sea. It is fished by English, Scotch, Norwegian, Swedish, Danish, German, Dutch, Belgian, and French fishermen, and I think I could prove to you (only it is unnecessary to go into statistics) that the fish which these fishermen are drawing from the North Sea, is worth at least 25 million of pounds every year. That sum, if I may translate the figures again into an intelligible language, is more than equal to the whole interest of the National Debt of this country. Now, I recollect that when we were at school, we used to read that Achilles, after his quarrel with Agamemnon, walked sulkily along the shore of what Homer was pleased to style "the barren sea;" and I recollect that Homer never lost an opportunity of stigmatising the sea by the opprobious epithet, "barren." The fishermen of Europe manage to draw 25 million pounds worth of food from this barren sea. This evening I am not concerned with the fisheries of Europe, but with the fish supply of London; and what I wish to point out to you, and what is very imperfectly understood, is the proportion of fish consumed in London, which is drawn from the North Sea. I have tried to analyse the return as far as I am able to do so, and I find that out of the 130,000 tons of fish which were received in London in 1880, in round numbers 100,000 tons came from the North Sea; that is to say, that out of every four fish which we eat in London, three came from the North Sea. Now if this is the case, it is really essential to the subject for us to consider, however shortly, what is happening in the North Sea, because I know there is a prevalent impression that the North Sea itself, and the seas of this kingdom generally, are being over-fished, and that they are, in consequence, in danger of approaching exhaustion. I am bound to say that you will hear this allegation supported on good authority in Billingsgate, and that you may also hear it in many fishing villages on the coasts of England. I am personally not disposed to attach the importance to it which many other authorities do. Now, I will give you very shortly, if you will pardon a digression, my reasons for thinking that the North Sea, and the seas of this country generally, are not in danger of exhaustion. In the first place, the prophecy of approaching exhaustion is not a new one. It has influenced the Legislature for centuries, and it may be found in our literature for centuries. I was very much struck the other day on stumbling on a passage in Mr. Froude's "History of England," in which he gives an account of a good Bishop of St. David's, who was burnt at Carmarthen for heresy, in the reign of Mary. So long as 330 years ago this good Bishop had formed the opinion that the scarcity of herrings was due to the covetousness of fishers who in time of plenty took so many that they destroyed the breeders. That is 330 years ago, when probably not one herring was taken for every 10,000 that are taken now. This Bishop is not the only episcopal authority who held this opinion. I was very much struck three years ago, on paying a visit to a portion of the kingdom in which I now take a deeper interest, the Isle of Man, to find that one of the best Bishops who ever adorned the church of this country, expressed exactly the same opinion at the commencement of the last century; and so strongly impressed was he with the approaching decay of the herring fishery, that he directed a prayer to be read in every church—which is still read every Sunday in the Isle of Man—that Almighty God would restore and continue the blessings of the sea. That took place at a time when British fishermen never went out at all, but left it to foreigners to catch the fish for them. The same thing will be found stated by Mr. Lecky, who, in writing of the middle of the century, says that the Irish were impressed with the approaching decay of the fisheries, which they attributed to the recent introduction of trawling. Just the same complaint is going on in Ireland now, though trawling has increased tenfold. In the very year that our Queen ascended the throne, I found a petition which had been presented to Parliament in these terms, that the fishermen of Ireland, Scotland, and Holland, had found out the breeding places of the herrings, had resorted there to catch them and that since the discovery was made, the fish generally throughout the west and north of Scotland had annually decreased. Now, it is a striking fact that at the very time that this petition was presented, the herring fishery was increasing year by year, and that its yield now is more than four times greater than at the time when this gloomy prophecy was made.

I, for one, think that when you find a series of predictions which have uniformly proved false, you may pretty well afford to disregard the same predictions when they are made in our own time. It reminds me of the prophecies which we continually hear, and which have been heard from age to age by our ancestors, that the world was certain to end within the next 100 years. The last I recollect was the famous saying attributed to Mother Shipton, that "The world to an end would come in the year 1881." Mother Shipton proved just as false as all her predecessors; the world is going on, and, I for one, have tolerably well made up my mind that it will out last my short life. Just in the same way I am tolerably clear that the fisheries of this country will out last any of us. You may possibly say that, however true this be as a general proposition—and of course you will understand I am speaking of the sea fisheries of this kingdom, not of the inland fisheries—however true this may be as a general proposition, it is not true of particular kinds of fish. You can hardly enter into a drawing-room—you certainly cannot go into any company interested in fisheries—without hearing complaints of the scarcity of soles; and I do not deny that soles were exceptionally scarce last year. But I recollect that I was told myself at Scarborough, that 45 years ago, in the year in which the Queen came to the throne, a fisherman landed at Scarborough with a pair of soles, which he placed on the pier, and said, "There are the two last soles in the North Sea." I think that is a tolerably decisive proof that scarcities of particular fish have occurred in the past: I do not deny that scarcity may occur again, as it undoubtedly occurred last year. But I regard such scarcities as temporary accidents, and not as any permanent failure of the great source of fish supply. You all know the enormous influence which a warm or cold year has on the production of insect life and vegetable life. We all talk of a plague of caterpillars, a plague of flies, a plague of gnats, and so forth. But exactly the same thing is going on in the sea, and the minute forms of life on which the fish feed are affected by the warmth or cold of particular summers. When there is a failure of those forms of life, the fish are occasionally obliged to scatter in search of food, and are not, therefore, collected together to be easily caught by the net fishermen. I do not wish dogmatically to assert—I am far from wishing to do so—that this is the true explanation of the failure of the supply of soles; but I will venture to say that the explanation is at least as good as that which is commonly urged, viz., that the North Sea is over-fished. The fact is, that fish, like all other animals, have a tendency to reproduce their numbers in greater ratio than their food, and consequently the natural waste which is perpetually going on in the sea is far greater than any effect which sea fishermen have upon the fish. If people would only read Mr. Malthus's great work on population a little more, and abuse him a little less, there would be many fewer errors expressed in the world. If I am not tiring you on this subject, I should like to illustrate the matter a little more pointedly. We are singularly deficient, I am sorry to say, in all statistics about fish, but we happen to have some more or less accurate statistics about one fish—the herring. Now we know that the Scotch fishermen, on an average, take 1,000 million herrings a year. I am sorry to use big numbers but I cannot avoid it, and we know that the Norwegian fishermen take from the North Sea another 1,000 millions of herrings a year, while I am sure that I am within the mark that the other fishermen who fish the North Sea take a third 1,000 millions a year from the North Sea. Therefore we may assume, as a matter beyond doubt, that the fishermen of Europe draw 3,000 millions of herrings annually from the North Sea. I think it is proved beyond the possibility of a doubt that predaceous fish and predaceous birds kill in the course of each year as many herrings as all the fishermen, fish and birds combined, that is to say, man and other enemies of the herring, draw from the North Sea 6,000 millions of herrings a year, four herrings for every man, woman, and child on the face of the globe. Now, I do not suppose that anyone with the slightest acquaintance with the subject would say that all these enemies of the herrings succeed in catching one herring out of every hundred. I am sure they would not say they caught one in every ten; but to put myself beyond all possibility of error, I will assume they catch one in every two. Then the state of the account at the end of the year must be 6,000 millions of herrings have been taken, and 6,000 millions left alive. It is a fair assumption that of the 6,000 millions left alive, half are females and half are males, and it is obvious that the female herrings, if they have to maintain the stock, have each to produce two herrings to make the 6,000 millions—12,000 millions for the next year. But a female herring does not lay two eggs; she lays some 20,000 to 30,000. Let us assume she lays 10,000 eggs, it is obvious that nature intends that 4,999 eggs, out of every 5,000 which she lays, should be wasted or die before they grow into adult herrings. If it were not so, the whole sea would be nothing but herrings. If that is true, and it seems to me mathematically unanswerable, I think we may go on eating whitebait in London a little longer. I can give you, if I may turn to another animal, some other figures, which also seem to me remarkable. I do not know if any of you are aware that we imported into this country, last year, between 700 millions and 800 millions of hens' eggs. I should like to know what any of you would think of me if I were to get up in this room and say what fools my fellow-countrymen are for importing this number of hens' eggs. Chickens cannot be produced if there are no eggs. If these eggs are used, you will reduce the number of adult chickens, and there must consequently be a failure in the supply. What would be your answer? Why, you would say that the supply of eggs had grown from 400 millions to 800 millions, and that as it had grown in the past, so you hoped it would grow in the future. A hen lays on an average 100 eggs a year; that is against the 10,000 eggs of a herring: and yet there is no failure. But why? Because we rely upon the French hen-wives and the hens of France just in the same way as I rely upon the fish of the North Sea, and the English fishermen.

Now, if I have made this clear to you so far, I should like to summarise the general conclusions which I have formed up to this point. In the first place, I have endeavoured to show to you what the fish supply of London really means. In the next place I have endeavoured to show to you the amount of fish which annually comes to London. In the third place, I have tried to show how much more rapidly the supply of fish is increasing than the population. In the fourth place, I have wished to impress upon you that this supply is mainly drawn from the North Sea; while, in the fifth place, I have been at some little pains to try to prove to you that the North Sea is practically inexhaustible.

Now, if I have been so fortunate as to make myself so far clear to you, I will go on to another very important subject, the manner in which this vast amount of fish is brought to London. Originally the supply of fish to London was chiefly carried by water. Since the introduction of railways, it has been mainly carried by rail, and the railways have been gradually superseding water-carriage. But during the last few years a contrary tendency has again arisen; and while the land-borne fish has increased, I think I am right in saying, in round numbers, from 70,000 to 87,000 tons, the water-borne fish has increased from 23,000 to 42,000 tons. In other words, while the land-borne fish has increased by rather more than 25 per cent., the water-borne fish has increased very nearly 100 per cent. Now, if this be so, there must be some reason for this remarkable increase. The reason, which I believe is the right one, is the excessive rates which are charged by the railway companies. I am particularly anxious to avoid attacking or saying a hard thing of any corporation or any body of men, and in anything I say, you may depend upon it I shall try to avoid reflecting on any body, but at the same time, I cannot help pointing out this circumstance that the railway rates are apparently decisively interfering with the amount of railway-borne fish coming to London. The rates which railways charge for carrying fish to London are very various, they vary according as the fish are carried by goods trains or fast trains, and they vary according as the fish are carried at the risk of the consignor, or at the risk of the companies. Those variations are natural enough, but what is not natural is that the lowest rate which the railways charge for carrying fish to London at the risk of the consignor is, I believe, in most cases, if not all, considerably higher than the rates which they charge for other similar goods. I have a pamphlet before me written by Mr. Duff, who is an authority on the subject, and he makes the difference very considerable indeed; but I believe I am right in saying generally that it is considerable. I believe I am also right in saying that while it is reasonable enough that the railways should charge a higher rate for carrying fish at their own risk than for that which they carry at the risk of the consignors, the difference which they charge is totally unwarranted by the circumstances. Not one per cent. of fish which is brought to London goes bad, but the railway companies charge something like 50 per cent. to cover the risk of this one per cent. going bad. I think it is obvious that these charges must be a little too high. The railways of this country are in a peculiar position. They are great monopolies, and because they are monopolies many people think—I am not sure whether they think rightly or wrongly, and I am not going into that question—that it is the duty of the Legislature to interfere with the rates which they charge. The House of Commons, only last year, appointed a very important committee to consider the whole question of railway rates, and we may yet hope that some day or other, when other and more pressing matters have been disposed of in the assembly in which our Chairman sits, that they may be able to deal with this subject. But what I wish to point out to you is that whatever regulations our friends in Parliament make, I believe they will not be able to exercise so beneficial an influence on this subject as a good and healthy competition. Some of the great tradesmen in London who are interested in the fish supply, have already discovered that they can carry fish by water for less than half the sum which is charged for conveying it by rail; and, in consequence, that great fact is occurring, which I have pointed out to you, that water-borne fish is increasing by 100 per cent., while railway-borne fish has only increased 25 per cent. during the last few years. It seems to me clear that the railway authorities will have to reconsider their policy, or be in danger of losing an important branch of their business.

But if this competition is to exist, it seems to me that it must be the duty of any authority dealing with the subject, to stimulate, or, at any rate, to refrain from any course which may check, the increase of the water-borne fish. Now, the water-borne fish has one great advantage over the railway-borne fish at the present moment; the steamers which bring it to London bring it direct to Billingsgate, and it is carried at once into the market without the interminable transit between station and market, through narrow crooked streets, wholly inadequate for the purpose. If I am right in saying that we must trust to water competition to keep down the railway rates, I think it follows that whatever else we do, we must not remove the market from the waterside. That is the first conclusion on this part of my subject which I wish strongly to impress upon you. I know there are many authorities who think this metropolis is so vast, that its population is so great, that it will easily support two markets instead of one. I hear by your applause that there are a great many people in this room who assent to that opinion; they will pardon me, therefore, for pointing out why, although I agree with them in one sense, I wholly differ from them in another. It seems to me that very often controversialists would avoid a great deal of confusion if they would only begin by defining the terms which they use. Now the multiplication of markets may be very convenient for the individual householder of the great city, but I extremely doubt whether they are convenient for the purposes of wholesale trade. Let us consider what the wholesale trade requires, and what the retail trader requires in connection with the wholesale trade. The fishmonger fish has to buy in the morning a certain stock of for his day's use. Which is more convenient—that he should go to one market, where, within one building, he can have a choice of the entire supply, or that he should be forced to go to two different localities, possibly remote from each other, and buy half his fish at one and half at the other? It seems to be demonstrable that, for the sake of the retailer, one wholesale market must have the advantage over two. But it is not merely the convenience of the retail trader I am thinking of; I am speaking also in the interest of the consumer. The price of fish depends on the supply and on the demand. If you divide the supply between two markets, you always run the risk of enhancing the price at either, because the whole of the retail traders may go to that one, and they will, instead of having the whole supply before them, only have half the supply: while, if you concentrate the whole supply in the same market, you will reduce the price, because you will have the maximum quantity of fish to dispose of. Therefore, I say, directly in the interest of the retail trader, and indirectly in the interest of the consumer, one market has a decisive advantage over two. This very tendency to concentrate trade in particular centres exist in every other branch of industry. If you want to deal in the funds, you employ a broker who goes into the Stock Exchange. If you want to buy meat, you go to Smithfield. You do not have a choice of two markets; on the contrary, you have the choice of one. And this tendency of trade to concentrate itself is nowhere so visible as in the case of fish. Even taking the whole country, the tendency is to concentrate the fish trade in about three centres, and the tendency of the present age is more and more to concentrate the supply of the whole country in London, Birmingham, and Manchester. Somewhat also in Liverpool, but to a smaller extent. Well, if I am right in this conclusion, from which I see many of you dissent, we arrive at two points, first, that there should be one market as the centre of the fish supply, and next, with which you all agree, that that market should be at the waterside.

Now, having gone so far, you will probably wish me to express an opinion where that market should be. I own that if it were possible to improve Billingsgate at any reasonable cost—and by improving Billingsgate, I mean not merely affording adequate market accommodation, but simultaneously improving the approaches and standing-room around the market—then, in my judgment, Billingsgate would have the preference over all places, because it is now the centre of supply, and nothing seems to me so unwise as to try to divert trade from the natural channels in which it is already flowing. If, then, it is possible to do this within a reasonable cost, I think Billingsgate ought to be preferred over any other places. If it is not possible to do this, then I say go to some other market accessible to steamers from the North Sea, on the water side; make that as large and commodious as possible, and make it the great centre of your supply.

Now, before I conclude, you will probably expect me to express an opinion on the effect which the construction of such a market would have on the price of fish in London. I am not prepared to assent to all the statements which are made—some of them seem to me random statements—about the price of fish in London. I see it has been lately stated that while the price at Billingsgate only averages 2d. a pound, the price at the West-end shops in London averages from 8d. to 9d.; and it is inferred that this difference of price is due to the mysterious operation of a set of gentlemen commonly styled a ring. Now, I am not prepared to admit the facts, and I am prepared to dispute the inference. I extremely doubt it being possible for the retail traders to quadruple the price between Billingsgate and the consumer; but if they do so, I am quite clear that this quadrupling the price cannot be due to the Billingsgate ring; and in justice to this maligned ring, some of whom are in this room, I think it only right to give my reasons for my opinion. The operations of the ring at Billingsgate, it seems to me, can only have the effect of increasing the price at Billingsgate. The utmost the salesman can do at Billingsgate is to screw the price up to the sum of 2d., which they say is the price there. As soon as the fish leaves Billingsgate it gets into the hands of the retail traders, and then the ring at Billingsgate has nothing more to do with it.

If that is so, and it is really true that the 2d. grows to 8d., you must in justice attack the retail trader and not the Billingsgate ring. But I for one doubt the fact. I doubt the price at Billingsgate being so low as 2d., and I doubt the retail price being so high as 8d. or 9d., and I think that the error is arrived at because people go to Billingsgate at a time when cheap fish happen to be sold, and they go to the West-end shops of London, which are selling the higher class of fish, and not to the costermongers, who are retailing the cheaper fish. But of course, in calculating the price, you must in fairness take the cheap fish which are retailed by costermongers as well as the high-class fish retailed by Mr. Grove and Mr. Charles. Whether this be so or not I have no doubt the price may be reduced appreciably by the provision of an adequate market. I think I have said before the price is regulated by the supply and demand. If you go to Billingsgate any morning, you will see how the present system is decreasing the supply. The streets are so narrow, that the fish cannot get into the market; it comes in by driblets, and in consequence, the retail fishmongers, instead of having the whole mornings supply before them, are obliged to choose from a limited supply, coming in in small quantities. Of course the salesmen are able, and let me tell you it is not merely that they are able, but it is their duty on behalf of their consignors to screw up the price in this state of things. Their duty is totally different from our interest. It is their duty to get the best prices for those for whom they are selling; it is our duty to take such precautions as will prevent them extorting unreasonable prices. Therefore, I for one, think that if a really adequate market is constructed, we may hope to affect an appreciable reduction in the price of fish supplied to London.

Now, on this subject, although it will not command universal assent, I wish to summarise my conclusions, that, in my judgment, there should be one fish market for London—not necessarily one market for retail purposes, but or wholesale purposes; that that market and centre of distribution shall be by the river side, and that there is reason to hope, if that market s adequately constructed, that an appreciable reduction will be made in the price of fish in London.

Now, I am glad to tell you that I have finished, and I am afraid you will think it is a dull story I have had to tell; but as this is the last opportunity probably which I may have of addressing an English audience on the subject of fisheries, I should like to add a very few words on another and kindred branch of the subject. The fisheries of this country have attained a degree of extraordinary prosperity. I recollect that when I was first officially connected with them 15 years ago, people would almost have laughed at you if you had talked of fisheries as a matter of much importance. I do not think they are inclined to laugh now. After the Exhibition which was held last year, under the auspices of our Chairman, at Norwich; after the great Exhibition which was held this year at Edinburgh; with the prospect of a still greater Exhibition before us, which will be held next year in London, every one is prepared to admit the importance of the fisheries of this kingdom. The most illustrious and eminent persons in the land preside at and attend meetings to promote fishery exhibitions; the members of the present Government vie with members of the late Cabinet to show their increasing interest in the subject. I own that this very circumstance fills me with one apprehension. Fisheries, 15 years ago, were in danger of neglect. I sometimes think now they are in still greater danger from patronage. The English fisherman has won his great and prosperous position from being left alone, Do not do him the disservice of turning an independent, honest man into a dependent one. The fisheries of this country have been fostered by freedom; do not let us harass the fisherman with unnecessary restrictions, or hamper him with foolish and unwise patronage. But, gentlemen, though I say this as a last word of warning to you, do not think that I do not sympathise with the hardships which every fisherman has to undergo. I have seen the hardships of his life, and no one more deeply sympathises with him in them. We sometimes forget that, for our sakes, to provide us with a dish of fish in the morning, the fisherman trusts not merely his whole life, but his whole fortune, to a slender plank between him and the sea; and we too frequently forget the toll which the sea annually demands of these brave public servants. I recollect—and I tell the story to my own shame—one day on the east coast of Scotland, standing on the Scotch sea-board, saying, "What a fine sight this must be in a gale of wind." A woman standing close by said to me, "Sir, you would not say that if you were a fisherman's wife." I can only say, gentlemen, that I hope her just reproof made me a better man. I recollect as I walked away I thought of those beautiful lines of a good man and a good poet—

> "For men must work and women must weep
> And there's little to earn and many to keep,
> Though the harbour bar be moaning."

DISCUSSION.

The CHAIRMAN said he could not but feel some regret at the remark of Mr. Walpole, that this would be the last occasion he would have of speaking on this subject before an English audience; but he hoped he would not be so entirely banished in the Isle of Man but that he might come again amongst them occasionally. He had given them figures showing that, roughly speaking, about 130,000 tons of fish came into London in 1880, but he (the Chairman) had figures before him, which he believed were quoted at the meeting in Willis's-rooms in February last, showing that, in 1881, the quantity was 193,996 tons, or an increase, in round numbers, of 64,000 tons in one year. He should like to say a word or two with regard to his own experience in the North Sea, for though he had been up amongst the whales, and walruses, and seals, in 80° north latitude, he had also spent a good deal of time, and had a good deal of experience in trawling in the North Sea, all down the Norwegian and Dutch Coast; and he might say that on one occasion, when in a fine Yarmouth trawler, he remembered the trawl being put down for about five hours, and when it was hauled up, the decks were covered with fish, almost up to his knees in depth. He would also say that in his own county, Norfolk, he, and many other farmers, used an enormous quantity of fish as manure, for it was one of the cheapest and best manures they could use. Although he was about 35 miles by water-carriage from the sea, fish was so cheap that he used an enormous quantity of it, and all his fellow agriculturists did the same. Surely there must be something radically wrong somewhere, when he was using what evidently was good and wholesome fish for such a purpose, and when they heard that in London the fish supply was so short. There must be some stumbling block between the producer and consumer. He agreed with Mr.

Walpole, that this stumbling block was due to the railway rates. He had said so before, and when the occasioncame, he should say so again in the House of Commons. They had heard a good deal about Billingsgate, and he thought it was only right that any member of Parliament, who took an interest in any Parliamentary matter, should investigate it for himself. He, therefore, went down to Billingsgate, as the Prime Minister did on one occasion; he had been there not only in the day time, but at four o'clock and five o'clock in the morning to see what went on. He had there seen for himself that what had been stated in print was perfectly true, that in the first place the narrow streets were blocked up on certain occasions when there was a heavy supply of fish which could not be brought to market, and also there was not the accommodation which was required, and which could be obtained if the Corporation would only give it. Mr. Gladstone went on to the Custom-house quay, and saw that there was ample space there which might be utilised for extending the market. With regard to the price of the fish which was sold in Billingsgate, he had figures before him showing that in 1880, Messrs. Hewitt sold 13,000 tons of fish at 1¾d. per lb. It appeared to him that was a very cheap price indeed, and he only hoped that the consumers all over London would be able to benefit by this price. It was evident there was another stumbling block somewhere, but if he went into that question more fully, he should probably be treading on some one's toes, and, therefore, he would refrain. He was glad to see that there were not only many practical gentlemen present, whom he hoped would take part in the discussion, but also the highest authority in England on such matters, his friend Professor Huxley.

Mr. GEORGE STEVENSON said the fish salesmen of Billingsgate had done a great deal to develop the trade, and open up new sources of supply. At one time fish could not be obtained from Brixham, Hull, and many other places, not only on account of the cost, but the great delay which took place, but now they were getting mullet at 4d., 6d., and 1s. each; which formerly cost 5s., 6s., or 7s. This being so, they ought to expect the fish sent to London to increase; and the only reason it decreased and the price went up, was on account of the wholesale destruction of young fish and spawn, occasioned by the wholesale system of trawling. He asserted that this system, especially of steam trawling, not only destroyed the fish, but would eventually take away the means of living from an industrious class of men, who not only supplied the country with fish, but defended our shores in time of war. Trawling was not allowed on the Norwegian coasts, where he and Mr. Bell had opened up many fisheries. With regard to the site for a fish market, he maintained that Billingsgate was in the very centre of the metropolis, and that fish sold there could be taken all over London, sold, and eaten in the time it would take to bring it from Shadwell. Hungerford market was a complete failure, and so was Columbia market, though it was given to the City by the Baroness Burdett-Coutts. All that was wanted was to enlarge Billingsgate, and to open up the approaches, and this could be done at absolutely no expense, because the increased value of the property opened up would more than repay all the cost, besides being of great advantage to the largely increasing fruit trade, which was also carried on in the neighbourhood.

Professor HUXLEY said he experienced much the same sensation as Rip Van Winkle must have felt when he awoke after his long sleep; for the speech he had just heard was identical in spirit, and almost in words, with a great multitude of speeches which came before him about 20 years ago, when he had the honour of being a Royal Commissioner to inquire into the condition of our sea fisheries. That Commission arose in this way. Mr. Milner Gibson, who was then President of the Board of Trade, sent for him one day, and told him that a member for a northern county meant to move for a Commission of inquiry into the destruction of the fisheries on the east coast by trawling, and asked him what he thought about it. He ventured to say that he thought it was all nonsense, and that Mr. Milner Gibson had better refuse the Commission. He did so, but the member beat him in the House of Commons, and he sent for him (Mr. Huxley) next day, and told him he must serve on the Commission. He served on it for two years, during which time a larger body of evidence came before him than had come under the eyes of most people. The complaints then made of trawlers were precisely those they had just heard, that the damage done to line fishermen was destroying a great source of the supply of men to the Navy; that it was destroying the breeding of fish in the North Sea, more especially cod, whiting, and haddock; and, not only so, but it was rapidly destroying that upon which the trawlers themselves subsisted. It came out in the evidence, first and foremost, that the fishing population supplied no appreciable contingent to her Majesty's Navy. It came out, in the second place, that the charge made against trawlers, that they would destroy the spawn of the fish ordinarily caught by the long lines, had no foundation; for, although it might appear strange for him to say so, yet he believed there was no body of men more absolutely ignorant of everything relating to fish, except the catching of them, than fishermen. The first complaint which came before them was that the trawlers were bringing up an enormous quantity of spawn every day in their trawls; but, upon inquiry, it turned out that what was supposed to be spawn, was nothing but gelatinous inhabitants of the sea, which had just about as much to do with fish as cocks and hens had to do with Jumbo. With regard to the charge made against trawlers, of destroying spawn, he might mention that such fish as haddock and cod did not lay eggs at the bottom of the sea; they floated at the top—so that it was impossible that the trawlers should destroy the spawn. Since that time, there was abundant evidence to prove that while trawlers had gone on steadily increasing, there had been no diminution in the number of cod, haddock, and whiting caught. Lastly, as to the supposed injury that the trawlers were doing themselves; there was no question that up to the present moment the amount of capital invested in trawling vessels had steadily increased, and he could not understand shrewd and clear-headed people like the last speaker putting their money into a business if it did not pay expenses. He could not describe the audacity of the statements made at that time with respect to trawl fishing. Witnesses came before the Commission and stated that trawled fish were unfit for human food, that they were poisonous; and one man summed up all the demerits and atrocities of trawl fish, by saying that they were "mashiated," though what he meant by the remark it is impossible to say. Beyond all doubt, if anything were done to stop trawl fishing on the enormous scale on which it was now carried out in this country, it would no longer be a case of complaining of the price of fish, but 99 out of 100 would not be able to buy any fish except herrings and the like, which were caught in the open sea by nets. He could not give the figures now, but he recollected it being stated some time ago, that 800 trawlers hailed from the Port of London, and, therefore, it was preposterous to talk of interfering with their fishery. No answer had been put forward to the arguments adduced in the report to which he had referred, namely, the constant increase of capital put into the trawling business, the constant increase in the tonnage of the vessels employed; and to such patent facts as these, that a town like Brixham was absolutely built out of trawled fish; and the trawlers who caught the fish, had trawled over a comparatively small area, close to Brixham, for the last 70 or 80 years, but the fishing was going on now as well as ever.

Mr. Sheppard Scott said he had not received the slightest particle of information, as a member of the fish-eating community, from the remarks which Professor Huxley had made. He dissented from the opinion of the Professor as to fish-spawn floating on the surface. The one prominent matter for them to consider was how to get fish cheap, and the only way to do this was to give every facility to the fishermen to catch the fish, and for cheap carriage to market. Allusion had been made to the evidence given before the Fish Supply Commissioners of the Corporation, and, as a member of that body, he might say that 13,500 tons were brought to Billingsgate market and sold at 1⅓d. per pound, but the public paid a very different price for this fish.

Mr. Stevenson said the fish sold at low prices fell into the hands of costermongers, and was sold by them for food.

Mr. Sheppard Scott thought that if a fishmonger had to send a mile or two in order to obtain a 2s. order, he had a perfect right to make a profit, and it was not right that the Billingsgate salesmen who sold his fish at 1⅓d. a pound, should be made a scapegoat.

Mr. J. Hornblower could not agree with Mr. Scott that nothing was to be learnt from Professor Huxley's remarks. He also knew, from personal experience, that Professor Huxley had given an immense amount of practical information to the Committee of the Common Council.

Mr. Bedford, as a member of the Court of Common Council, had taken considerable interest in the matter; he thought that the question to consider was, whether Billingsgate was sufficiently capacious to receive the whole of the fish sent to the metropolis. His opinion was that it was not, and that the market was a disgrace to the Corporation, as it was ill-adapted for the purpose for which it was intended, especially its approaches. Having sat upon the Special Committee, he had heard evidence to the effect that the average detention of the vans going from the station to the market was four hours, and sometimes more than that. The evidence of the manager of the London and Brighton Company was to the effect that it sometimes took eight hours to get a van of fish from London-bridge to Billingsgate, and this fact showed that a large alteration was wanted in the shape of the market at the waterside. He thought the Corporation had made a great mistake in opposing the scheme which had been proposed; but the question to consider was, not what was to the interest of the Corporation, but what was to the interest of the public, and this was a subject to which any man might with advantage dedicate his whole life. He, and those who acted with him, did not intend to cease their efforts until they had succeeded in improving the present fish market.

Mr. Grier wished to confirm the statement of Professor Huxley, that the spawn was not all to be found at the bottom. He thought the success of the fishing interest depended on the union between the scientific and the practical.

Mr. Hodges said he had been employed by several wealthy gentlemen to prepare plans for a market, which he thought would follow the lines laid down by Mr. Walpole, Prof. Huxley, and Mr. Bedford. It was proposed to erect, near Blackfriars-bridge, a market which covered an acre and a half superficial; this market would be near the London, Chatham, and Dover, and the District Railways, and would have a river frontage twice the length of Billingsgate. To the east would be Queen Victoria-street, to the west the embankment, to the south Blackfriars-bridge, and the north Farringdon-street. He was prepared to answer any question that might be put to him with regard to the proposed market.

Captain BEDFORD PIM said that in Canton, fish were brought alive, in buckets, to the doors of the purchasers, and this might be done in England, if fishing vessels were constructed with deep wells, the valves of which could be closed when the vessel got into brackish water.

Mr. SCOTT asked whether Captain Pim had ever known of an instance of salt-water fish being brought alive to any house in Canton.

Captain BEDFORD PIM replied that his remark applied to fresh-water fish, but he thought the same thing might be done with salt water fish.

The CHAIRMAN said the time had arrived for closing the discussion; he had much pleasure in proposing a vote of thanks to Mr. Walpole for his interesting paper.

Mr. J. H. FORDHAM seconded the motion, which was put to the meeting and carried unanimously.

Obituary.

THOMAS WILLIAM KEATES.—Mr. Keates, Consulting Chemist and Superintending Gas Examiner to the Metropolitan Board of Works, died on Sunday, the 7th inst, at the age of 64. His health had been declining for some months back, but he continued the performance of his professional duties almost to the last. In early life he was interested in the development of the art of photography, and he was associated, to some extent, with Daguerre and others. As a scientific chemist, he was connected with the paper mills of Mr. Joynson, at St. Mary Cray, and the oil works of Messrs. Price and Co. Mr. Keates was elected a member of the Society of Arts in 1877, and he served on the Committees appointed to arrange for the Annual Conferences of the Society on National Water Supply, and the Progress of Public Health, in 1879 and 1880.

General Notes.

TECHNICAL EDUCATION IN SPAIN.—The Municipal Council of Mieres has decided to establish a school for training mechanical and mining engineers, foremen of works, engine-drivers, and firemen.

CHEMICAL INSTRUCTION IN PARIS.—The municipality of Paris is about to inaugurate a school for instruction in industrial chemistry and physics. Its object is to enable young men to acquire special knowledge which will enable them to fill important posts in works, in manufactories of scientific instruments, and also in connection with chemical investigations.

EXHIBITION AT SAINT QUENTIN.—An Industrial Exhibition is to take place at St. Quentin on the occasion of the *Concours Régional Agricole* and the Sugar Trade Congress. The opening is definitely fixed for 27th May, coincidently with the *concours*, while the 30th June is spoken of for the close. No charge is made for space.

MADRID EXHIBITION.—A movement is on foot for deferring the opening of the Madrid Exhibition from May to September, 1883, as being a more favourable season, and as giving more time to manufacturers to make a good show, as their energies are absorbed in the Spanish-American Exhibition.

SUBMARINE TELEPHONY.—In raising the vessel *La Provence*, which sank in the Bosphorus, the telephone was added to the diver's dress, thus greatly facilitating the communications. One of the glasses of the helmet is replaced by a copper plate, in which a telephone is inserted, so that the diver has only to turn his head slightly in order to receive his instructions, and report what he sees. Besides, in case of danger or accident, lives may now be saved which would otherwise have been sacrificed.

PREPARATION OF RHEA OR CHINA GRASS.—At a recent meeting of the Paris Société d'Encouragement, M. Simon reported on the process of decortication devised by M. Favier, retired captain of Engineer corps. The greatest drawback to the use of the rhea, or China grass, is said to be the slight proportion of textile filament which it possesses. To reduce the time and expense of preparation, M. Favier places the stalks, freshly cut to lengths of five to ten feet, in a wooden receptacle, to which steam is then admitted. The outside covering is afterwards removed very easily by children.

FRENCH SUGAR.—There are in France 256 sugar houses for producing sugar from mangold wurtzel, which is commonly but erroneously called beetroot; and of this number, 83 adopt the process of diffusion, which will probably ere long be universally employed.

UTILISATION OF SEA-WEED.—M. Alexandre Saint Ives is reported to have succeeded, after numerous experiments, in extracting from sea-weed a composition like that of starch and sugar, which is well adapted for the economical manufacture of certain articles of commerce, such as imitation leather, and transparent substances. The sea-weed, previously washed in pure water, or water impregnated with a little lime, or potash, is dried, and then pounded, or ground, according to its variety, and introduced into a conical boiler. A soluble substance is extracted by a bath of hot water or steam, when the residue, on cooling, assumes a gelatinous consistency.

HEATING BY MEANS OF PETROLEUM.—Colonel Sebert lately drew the attention of the Société d'Encouragement to an apparatus devised by M. Pestlund, for heating with petroleum. To diminish the dangers due to this substance, it is preferred to use only the less volatile oils, which may be separated in treating the raw petroleum; but these oils can only burn with the aid of special wicks, which it is desirable to dispense with. The inventor has recourse to the pressure produced by compressed air, for causing the oil to rise in the burner, the pressure being produced by injecting air into the reservoir by means of a tube and hollow indiarubber bath, alternately compressed and allowed to expand.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock:—

MAY 17.—"The Constant Supply and Waste of Water." By GEORGE F. DEACON. Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, will preside.

MAY 24.—English and Foreign Technical Education. By E. C. ROBINS, F.S.A. Professor FLEEMING JENKIN, F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evening, at Eight o'clock:—

MAY 23.—"Recent Passages of Zulu-Kafir History." By ROBERT JAMES MANN, M.D., F.R.C.S., F.R.G.S. The paper will be illustrated by means of the lime-light lanthorn.

INDIAN SECTION.

Friday Evening, at Eight o'clock:—

JUNE 2.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE. [This date has been altered from May 26.]

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Fourth Course is on "Book Illustration: Old and New." By J. COMYNS CARR.

LECTURE 2, MAY 15.—Various modes of book illustration. Modern development of wood engraving. American engravers.

LECTURE 3, MAY 22.—Modern processes of illustration. Influence of photography. Surface printing. Intaglio printing.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. Comyns Carr, "Book Illustration: Old and New." (Lecture II.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. John Slater, "Recent Progress in the Electric Lighting of Buildings."

London and Middlesex Archæological, 4, St. Martin's-place, W.C., 8 p.m. Mr. G. B. Hall, "St. Alphage, London Wall."

Victoria Institute 7, Adelphi-terrace, W.C., 8 p.m. Prof. Lionel S. Beale, "Dictatorial Scientific Utterances, and the Decline of Thought."

Law Amendment, 1, Adam-street, Adelphi, W.C., 8 p.m. Discussion on the "Copyright (Works of Fine Art, &c.) Bill," to be opened by Dr. J. Westlake.

TUESDAY, MAY 16...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "Digestion." (Lecture I.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. W. Procter Baker, "The various Systems of Grinding Wheat, and the Machines used in Corn Mills." 2. Mr. Henry Simon, "High Grinding by Roller-mills in England." 3. Mr. William Bishop Harding, "Roller-mills and Milling as practised in Buda-Pest."

Statistical, Somerset-house-terrace, Strand, W.C. 7¾ p.m.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Menagerie in April." 2. Rev. O. P. Cambridge, "New Genera and Species of Araneidea." 3. Mr. W. A. Forbes, "Some Points in the Anatomy of the Todies (*Todus*), and on the Systematic Position of that Group."

WEDNESDAY, MAY 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. George F. Deacon, "The Constant Supply and Waste of Water."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Hon. Ralph Abercromby, "The Diurnal Variation of Wind and Weather in Relation to Isobaric Lines." 2. Mr. W. F. Stanley, "Mechanical Conditions of Storms, Hurricanes, and Cyclones."

Pharmaceutical, 17, Bloomsbury-square, W.C., 11 a.m. Annual meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. J. Greenstreet, "The Camden Roll of Arms." 2. Mr. E. P. Loftus Brock, "Ancient Remains on the Site of the new Stock Exchange."

Royal Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. Exhibition of Summer Plants and Flowers.

THURSDAY, MAY 18...Chemical, Burlington-house, W., 8 p.m. 1. Dr. E. J. Mills and Mr. R. L. Barr, "The Precipitation of Alum by Sodic Carbonate." 2. Mr. W. H. Perkin, "Rotary Polarisation by Chemical Substances, under Magnetic Influence."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Metals" (Lecture V.).

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Society of Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Augustus Stroh will repeat his Experiments in connection with Attraction and Repulsion due to Sonorous Vibrations, and will compare the Phenomena with those of Magnetism.

FRIDAY, MAY 19...Royal United Service Inst., Whitehall-yard, 3 p.m. Mr. St. George Lane-Fox, "The Future of Electric Lighting, and the Exhibition at the Crystal Palace."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., Sir Frederick Bramwell, "The Making and Working of a Channel Tunnel."

Philological, University College, W.C., 8 p.m. Anniversary Address by the President, Mr. A. J. Ellis.

SATURDAY, MAY 20...Royal Institution, Albemarle-street, 3 p.m. Prof. D. Masson, "Poetry and its Literary Forms." (Lecture I.)

Geologists' Association, University College, W.C. Excursion to Tilgate, Cuckfield, and Hayward's-heath.

Journal of the Society of Arts.

No. 1,539. Vol. XXX.

FRIDAY, MAY 19, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FOREIGN AND COLONIAL SECTION.

In consequence of the absence in Africa of Captain Cameron, R.N., and Captain Richard Burton, there has been some uncertainty as to the date for the reading of their paper on "The Gold Fields of West Africa." It has, however, now been found possible to arrange for the paper to be read on the date originally fixed, viz., May 23rd. Dr. Mann's paper, on "Recent Passages of Zulu Kafir History," will be read on Thursday, May 25th.

CANTOR LECTURES.

The second lecture of the fourth course of Cantor Lectures on "Book Illustration, Old and New," was delivered by Mr. J. Comyns Carr on Monday evening, May 15. The subjects specially dealt with were various modes of book illustration, the modern development of the Art, and American engravers.

The lectures will be printed in the *Journal* during the autumn recess.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 14th June. The cards of invitation will be issued shortly.

EXHIBITION OF MODERN ENGLISH POTTERY.

This Exhibition will be opened on Wednesday, the 24th inst., instead of Monday, 22nd, as announced, as it has not been found possible for all the exhibits to be ready by the earlier date. The following firms have, on the invitation of the Council, kindly consented to exhibit specimens of their work:—Messrs. T. C. Brown-Westhead, Moore and Co., Messrs. Henry Doulton and Co., Mr. Harrison (Linthorpe Pottery), Messrs. Maw and Co., Messrs. Mintons, Messrs. Wedgwood, and the Worcester Royal Porcelain Works. The Exhibition will probably be kept open every day from 10 to 4, from May 24th until the end of June.

Members of the Society will be admitted on signing their names. They can admit their friends by use of the tickets supplied for the evening meetings and lectures.

A Catalogue of the Exhibition will be published in the *Journal.*

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, assisted by W. A. Barrett, Mus. Bac. Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 10th July, 1882.

Honours.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

First and Second-class.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named

by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

Full particulars can be obtained on application to the Secretary.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, April 27, 1882; WALTER WELDON, F.C.S., in the chair.

The paper read was:—

THE RECOVERY OF SULPHUR FROM ALKALI WASTE (SCHAFFNER AND HELBIG'S PROCESS): A RECORD OF RECENT RESULTS.

By ALEXANDER M. CHANCE.

Invented and applied in France by Leblanc, about the year 1790, and first introduced into England by Mr. Muspratt, in 1823, the manufacture of soda from common salt—generally known as the alkali trade—has gradually extended, until it has become the most important of all the chemical processes in Great Britain. Upon its production depend the manufacture of glass, soap, paper, and of many other articles of every-day use throughout the civilised world, whilst the quantity of raw materials required, and the labour and capital employed, render the alkali trade one of the leading industries of this country.

But apart from the interest which any such industry necessarily creates in a manufacturing country like England, there are special features incidental to the alkali trade which have, from the very outset, caused much more general attention to be bestowed upon alkali makers than they themselves have desired.

In transforming chloride of sodium (common salt) into carbonate of soda (common soda), by Leblanc's process, two by-products are produced, to deal with which, so as to prevent annoyance to their neighbours, and injury to adjacent property, has not only taxed to the utmost the ingenuity of the manufacturers themselves, but has also led to several special Acts of Parliament. These two by-products are, as is well known, hydrochloric acid gas and alkali waste.

Since 1863, the condensation of hydrochloric acid gas has been rendered compulsory, and this acid, once a source of anxiety and loss, has, with the progress of chemical industry, gradually acquired considerable commercial value, and is now, in many districts, an article of primary importance to alkali makers, principally for the manufacture of bleaching powder and of chlorate of potash. In works managed with ordinary care, it is now easily kept under perfect control. The other by-product, namely, alkali waste, forms the subject of our consideration this evening.

By Leblanc's methods, the conversion of salt into soda, whether as carbonate or as caustic, necessitates several chemical operations. The decomposition of salt by sulphuric acid into sulphate, and the conversion of sulphate, by the addition of limestone and coal, into carbonate, involve, as every alkali maker knows, the entire loss of the sulphur and the lime, which thus become the chief constituents of the bulky, insoluble mass known as alkali waste. Of the two materials so lost, by far the more costly is sulphur, the cheapest supply of which comes to us from abroad in the shape of pyrites (principally from Spain); and it has long been felt that means ought to be found to prevent this enormous waste of sulphur.

According to the Board of Trade returns, as kindly supplied to me by Mr. William Smith, of Bristol, the following table shows the imports of brimstone and pyrites into the United Kingdom, during the years 1880 and 1881:—

	1880.	1881.
	Tons.	Tons.
Brimstone	46,896	40,561
Pyrites	657,867	542,046

We have thus a yearly average of 599,956 tons of pyrites for these two years, or in round numbers, say, 600,000 tons a year, for 1880 and 1881.

Let us now try to ascertain how much of the sulphur in this large quantity of pyrites is lost in alkali waste. According to the returns of the Alkali Association, we find that in 1880, 700,016 tons of salt, and in 1881, 675,099 tons of salt were decomposed, showing an annual average for 1880 and 1881, of 687,557 tons decomposed.

Now as from the sulphur in one ton of Spanish pyrites about 1¾ tons of ordinary salt may be decomposed, we find the quantity of pyrites

SUPPLEMENT TO THE JOURNAL OF THE SOCIETY OF ARTS. 19TH MAY 1882.

GRAPHIC REPRESENTATION OF THE RATE OF SUPPLY DURING EACH INSTANT OF 24 HOURS IN A DISTRICT OF 1,933 PERSONS.

Fig. 1.

▨	Water Wasted by Hidden Defects	9·9	Gallons per Head per Day
▨	" " " Superficial	5·0	" " " " "
	" Used or Misused	14·8	" " " " "
	TOTAL	29·7	" " " " "

Fig. 5. **LIVERPOOL**

Example of Waste Water Meter Diagrams from a District of 5,500 Persons.

Fine Diagram Jan. 1882 night inspection under W.W.M. system. Thick Diagram 3 following days after repair of leak recorded at 12.50 p.m. & before repair of other defects.

	SUPPLY per HEAD per DAY	
	TOTAL	WASTE
	21·00	16·58
	10·08	5·02
SAVING	10·92	11·56

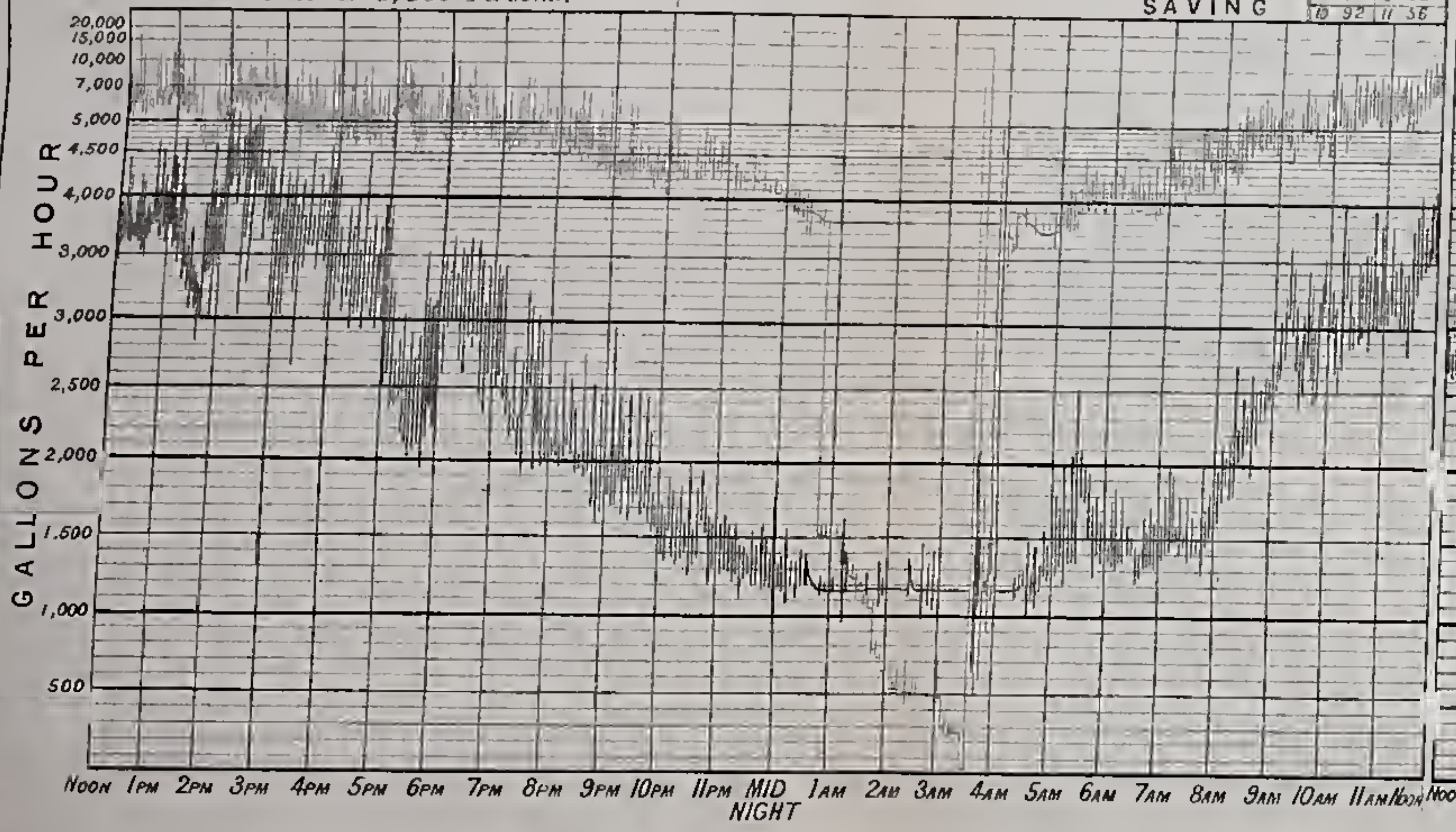


Fig. 6. **CHORLEY**

Example of Waste Water Meter Diagrams from a District of 4,095 Persons.

Fine Diagram Dec. 1881 night inspection under W.W.M. System. Thick Diagram Jan. 1882 after repair of leaks detected by one night inspection.

	SUPPLY per HEAD per DAY	
	TOTAL	TOTAL
	13·47	6·15
	9·77	2·20
SAVING	3·70	3·95

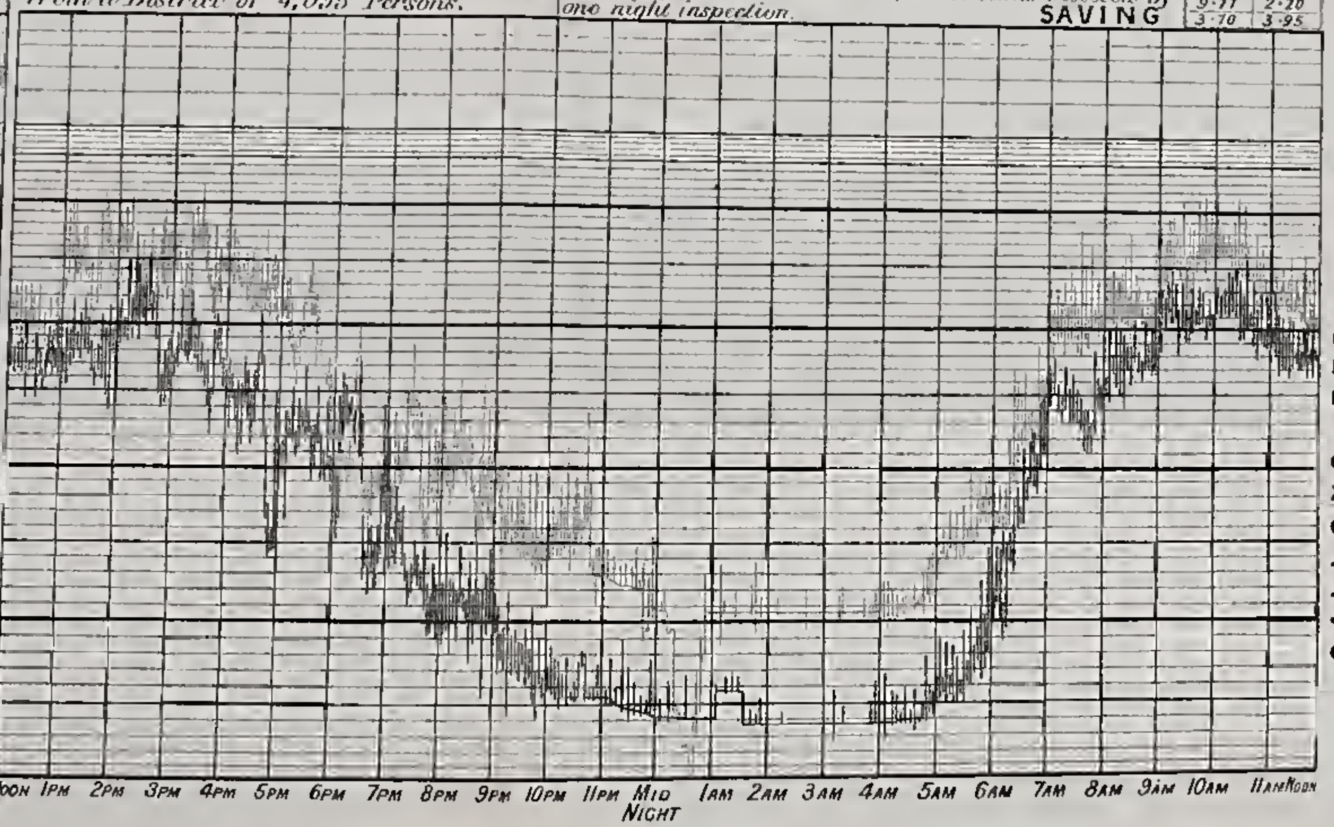


Fig. 4. **LONDON (LAMBETH WATER CO.)**

Example of Waste Water Meter Diagrams from a District of 2,744 Persons.

Fine Diagram Sep. 1881 before application of W.W.M. system. Thick Diagram Nov. 1881, after application of W.W.M. system.

	SUPPLY per HEAD per DAY
	47·0
	10·9
SAVING	36·1

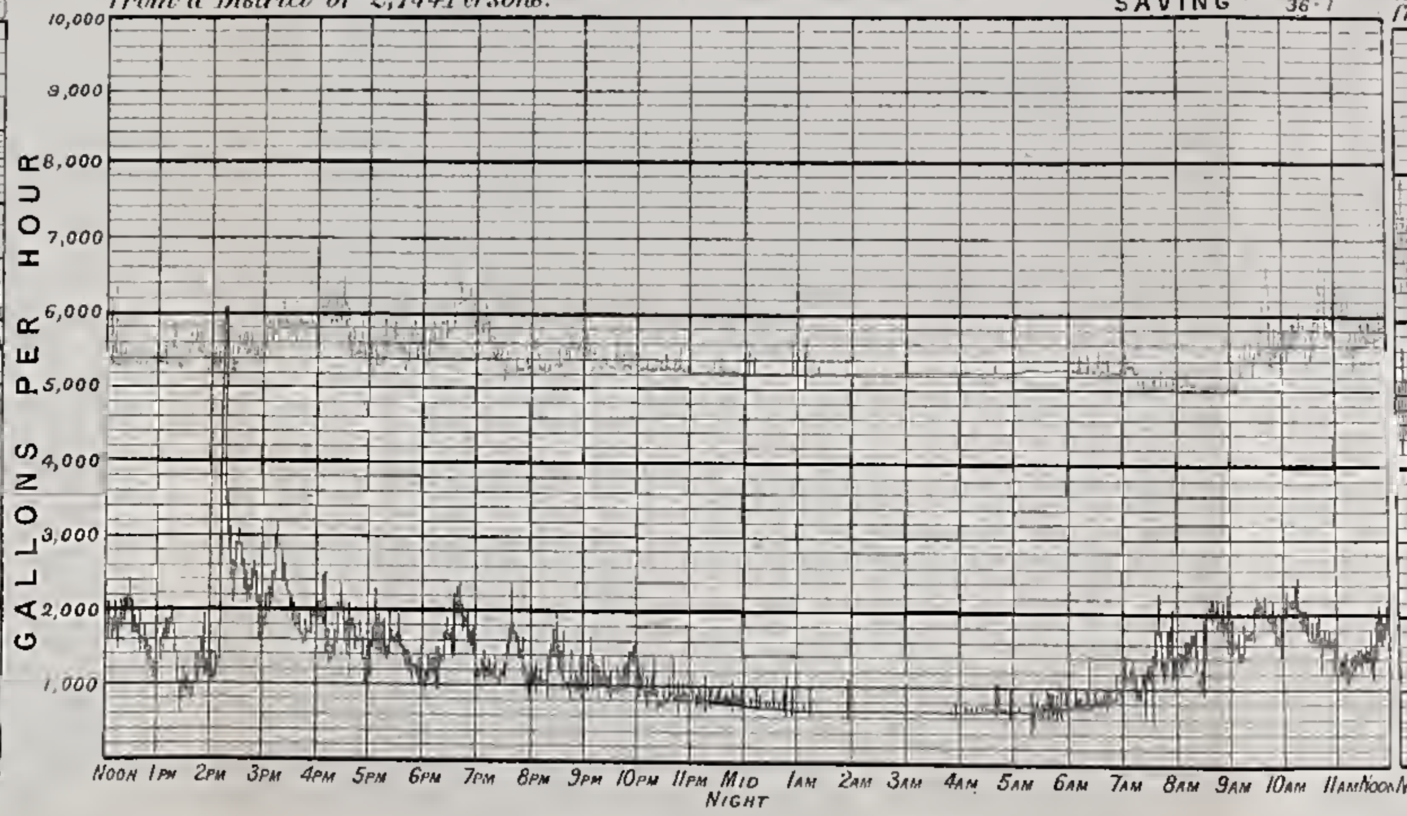
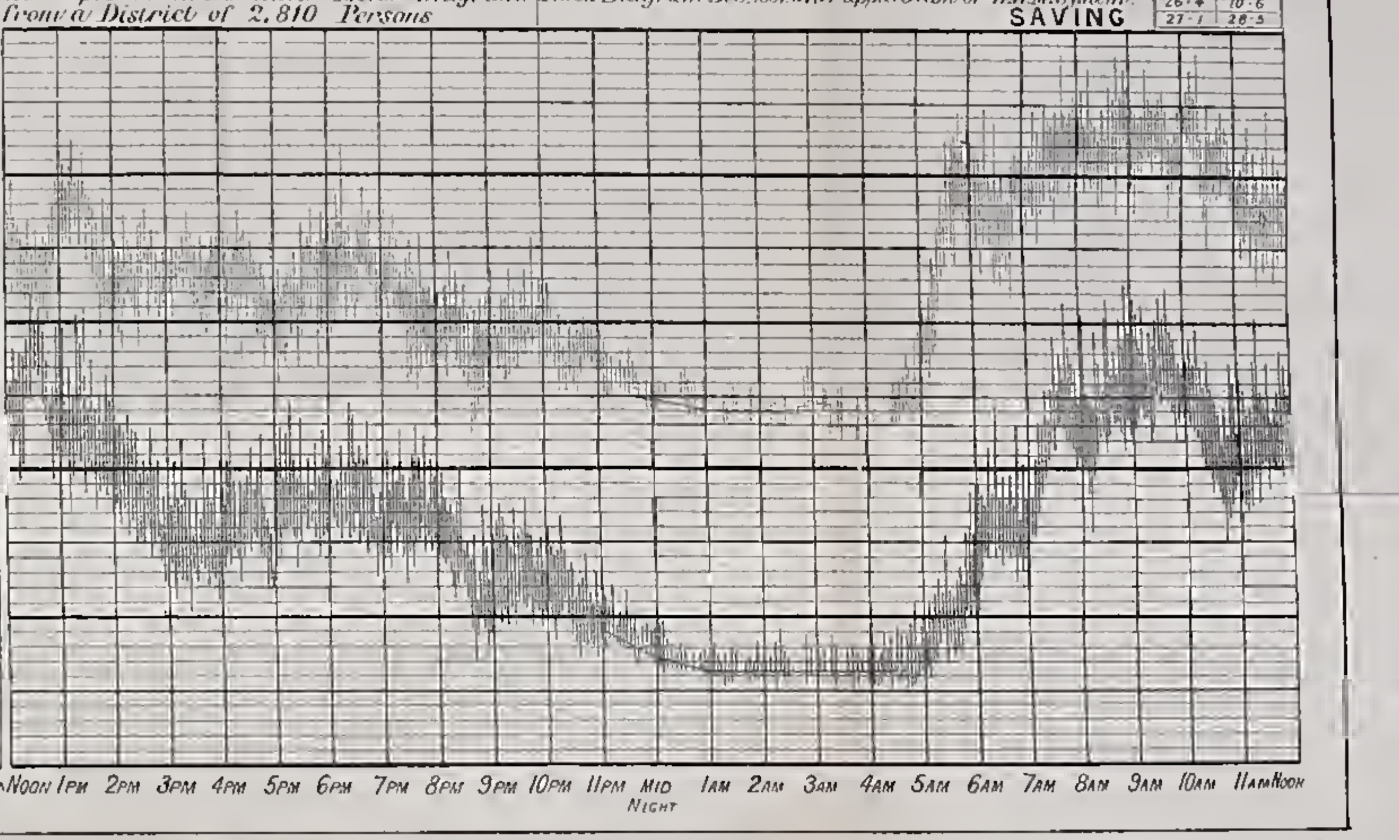


Fig. 7. **BOSTON U.S.A.**

Example of Waste Water Meter Diagrams from a District of 2,810 Persons.

Fine Diagram May 1881 before application of W.W.M. System. Thick Diagram Dec. 1881 after application of W.W.M. System.

	SUPPLY per HEAD per DAY	
	TOTAL	WASTE
	53·5	39·1
	26·4	10·6
SAVING	27·1	28·5



A.S. CATTELL & Co LITH, LONDON.

required to decompose 687,557 tons to be

$$\frac{687{,}557}{1{\cdot}75} = 392{,}890,$$

which figure therefore may be regarded as indicating the yearly average quantity of pyrites used in 1880 and in 1881, in the United Kingdom, for the decomposition of salt in the alkali trade. But part of the sulphate of soda thus made, was sold as sulphate, for glass making, and other purposes; and an allowance must be made accordingly. Assuming that the sulphate so disposed of required for its production 42,890 tons (an outside figure) of pyrites, equal to about 84,000 tons of sulphate, we have, in round numbers, 350,000 tons of pyrites actually imported for the manufacture of soda (more than one-half of the entire imports) of which from 80 to 90 per cent. of the sulphur is lost in the alkali waste.

At the present price of sulphur in pyrites, namely, 6d. per ton per unit, of an average strength of 48 per cent., the value ex ship is 24s. per ton, irrespective of the cost of inland carriage.

The minimum money value, therefore, of the sulphur thus lost may safely be computed thus:—350,000 tons at 24s., equal £420,000, of which 85 per cent., or £357,000, represents the loss of the sulphur in alkali waste.

These figures, estimated carefully, show the commercial importance of the question we are now considering. So long, however, as this loss of sulphur was shared by all makers of soda, and so long as no other method of manufacturing soda more cheaply existed, this loss, large as it is, fell rather upon the consumers than upon the producers of soda, and has hitherto been regarded by manufacturers as part of the cost of production.

Recently, however, the method known as the ammonia-soda process has been so successfully established on a large scale in England, that soda ash is being produced by it more, nay, much more, economically than by Leblanc's process, and thus the recovery of the sulphur from alkali waste, as a means of cheapening the cost of production by Leblanc's process, has become of vital importance.

The treatment of alkali waste is also forced upon the attention of manufacturers by the Alkali, &c. Works Regulation Act, passed in 1881, which came into operation on the 1st of January of the present year, by which alkali waste is, for the first time, made a subject of legislation.

Under section 6, it is enacted that "Alkali waste shall not be deposited or discharged without the best practicable means being used for effectually preventing any nuisance arising therefrom," and heavy penalties are attached to the non-observance of this requirement. By ceasing to have any alkali waste to deposit, alkali makers would, obviously, best comply with this provision; whilst, if they could, at the same time, profitably recover the sulphur and the limestone now lost, they might be enabled to compete successfully with the ammonia-soda process just named.

The sulphur recovery process of Messrs. Schaffner and Helbig seems to offer a satisfactory solution of this question; but before we pass on to it, we must refer, very briefly, to other sulphur recovery processes, in order the better to appreciate fully its true value and importance.

So far back as 1837, the late Mr. Gossage took out a patent for decomposing tank waste by hydrochloric acid, or by carbonic acid, and for employing the H_2S thus generated for making sulphuric acid. But although, to quote his own words, "he devoted thirty years of his life and a fortune" to this object, he failed to establish a process by which the sulphur could be profitably recovered. Since that time, many other chemists have also devoted much time, and thought, and money to this object; but of the numerous methods suggested, and of the many processes patented, only three need here be mentioned, namely, those of Schaffner, of Mond, and of Mactear.

According to Lunge (vol. ii., p. 652), the recovery of sulphur was accomplished nearly simultaneously (in 1861) by Schaffner and by Mond, who worked quite independently, and elaborated processes differing from each other in many details. The principle of each process, however, is the same, namely, the partial oxidation of the sulphur and calcium compounds in the tank waste, and the decomposition of the soluble compounds thus obtained by hydrochloric acid, by which a certain quantity of the sulphur originally contained in the alkali waste is recovered.

At the few works in England, where the recovery of sulphur from alkali waste has been carried out, the process adopted has been Mond's.

By the courtesy of Mr. Mond, I am permitted to publish the following results, which have been kindly furnished to me by the five firms in England who have used his process, designating, for obvious reasons, these firms by numbers and not by name:—

Mond's Sulphur-recovery Process.—Results of the five firms using it in England.

Firms.	Total tons of sulphur recovered.	Per-centage recovered of total sulphur in vat waste.	Tons of HCl used per ton of sulphur recovered.
1	6,690	30	$3\frac{1}{2}$ of 28° Tw.
2	1,500	27 to 30	4 of 25° ,,
3	3,200	*25 to 30	4 to $4\frac{1}{2}$ of 28° ,,
4	3,000	..	4 of 30° ,,
5	3,223	†17	not registered.

Total quantity of sulphur recovered = 17,613 tons.

In Germany generally (according to Lunge) Mond's and Schaffner's processes are combined, and Schaffner himself still continues, it appears, to use his process at Aussig with considerable success, which process Mr. Mond affirms to be now practically identical with his own. But these processes, although greatly in advance of all previous methods, fail to solve the alkali waste question, for the following three reasons amongst others:—

1st. At the most, only 30 per cent. of the total sulphur in the waste has been recovered by them in England.

2nd. A large quantity of hydrochloric acid is required for every ton of sulphur thus recovered.

3rd. The waste, after treatment, still forms a bulky, troublesome deposit, although apparently no longer liable to cause a nuisance.

In striking contrast with these three drawbacks, will appear the advantages of Messrs. Schaffner and Helbig's process, by which at least 90 per cent. of the sulphur may be recovered, whilst no hydrochloric acid is required — and the residue to be deposited will eventually be barely one-fifth of the original bulk; probably, even much less.

But this paper, purporting, as it does, to treat of the sulphur recovery question in England, as a whole, would be incomplete if reference were omitted to processes by which sulphur can be recovered from the drainage from old waste heaps.

Schaffner's and Mond's processes, as just described — whether separate or combined — deal only with fresh alkali waste, as produced, day by day. The treatment of the drainage from old alkali waste heaps has been ably dealt with by Mr. Mactear, whose process, as described by himself in a paper read before this Society in May, 1878, is in operation on a large scale at Messrs. Tennant's Chemical Works, at St. Rollox, Glasgow, of which he is technical partner.

The experience acquired by him in working this process, has led to certain modifications in the details, and the method now in use at St. Rollox, is that patented in 1878, No. 885, in which a solution of bi-sulphite of lime is used, prepared from old waste oxidised chiefly to sulphites, and then treated with SO_2.

The chief advantage claimed for this modified process, is that weak drainage liquors can be treated by it; and that, with the same plant, double the work can be done, as compared with the original method; but a serious disadvantage is, that it requires more hydrochloric acid per ton of sulphur recovered.

Mr. Mactear has kindly permitted me to state that already, by this process, over 14,500 tons of sulphur have been recovered at their St. Rollox Works.

Another mode of dealing with the drainage of old waste heaps, and, as it seems to me, a much simpler and more economical one, is that patented by M. Pechiney, and now in use at his works at Salindres, in France.

By an identical method, applied during the investigation of this subject by our chemist, Mr. Dryden, in complete ignorance of M. Pechiney's operations, the whole of the drainage of our waste heap is being satisfactorily dealt with at our Alkali Works, at Oldbury, near Birmingham. It consists simply of oxidising the drainage liquors in iron tanks, by means of a current of air and steam produced by a Koerting's injector, until the oxidation reaches the point when, by adding HCl, neither H_2S nor SO_2, is given off. By then adding HCl the whole of the sulphur is precipitated as impure sulphur, which is dealt with in the ordinary way, and a clear solution of chloride of calcium is run off. Fuller information concerning this simple and effective method of dealing with the drainage of old heaps will be found in Mr. Weldon's paper, read before the Society of Chemical Industry in London, in January last, and in the discussion which followed. Any communications respecting it should be addressed to Mr. Walter Weldon, who represents M. Pechiney's interests in the patent in this country.

This rapid review of the main features of the principal processes actually used in England for dealing with alkali waste, and of the results obtained, will be of service, in enabling us better to realise the great advance established by Messrs. Schaffner and Helbig's process, and to appreciate the influence it is likely to exert upon the future of the alkali trade.

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* Estimated.

† No record kept formerly; at present 17 per cent.

SCHAFFNER AND HELBIG'S SULPHUR RECOVERY PROCESS.

Although patented in England in March, 1878, this process did not become known to us, until its publication *in extenso* in Professor Lunge's admirable and exhaustive treatise on the Alkali Trade, issued in 1880, to which source, also, Dr. Angus Smith is indebted for the extracts given in his sixteenth annual report. From Professor Lunge's most valuable book, and from the original specification itself, full information can be obtained by all who desire to study the origin and the theory of this deeply interesting process.

To-night we have to consider, briefly, the chemical reactions and combinations discovered by Messrs. Schaffner and Helbig, the results obtained by our firm, as pioneers of this process into England, together with such other details and information as practical experience may have suggested.

Three distinct chemical reactions, involving three separate and distinct operations, constitute this process, as originated by its distinguished authors, Messrs Schaffner and Helbig.

I. The decomposition of the calcium sulphides in the alkali waste, by magnesium chloride, by which the sulphur is liberated as H_2S, *without being diluted with other gases*. This reaction is stated thus—

$$(1.)\ CaS + MgCl^2 + H_2O = CaCl_2 + MgO + H_2S$$

II. The reconversion of the magnesia (MgO) thus formed into chloride of magnesium, and the recovery of the calcium from the $Ca\ Cl_2$, in the form of carbonate of lime, by the action of carbonic acid gas, thus—

$$(2.)\ CO^2 + MgO + CaCl_2 = MgCl_2 + CaCO^3.$$

III.—The recovery of the sulphur from the H_2S, by precipitating the S by means of SO^2 thus :—

$$(3)\ 2\,H_2S + SO^2 = 3\,S + 2\,H_2O$$

Let us now consider these three operations in their order.

The first operation, that of the decomposition of the calcium sulphides by the $MgCl_2$ is very readily accomplished, if care be taken that the solution of $MgCl_2$ be of sufficient strength, and be present in excess. A solution of a minimum strength of 30 deg. Twaddell works advantageously.

Analyses of vat waste show that the sulphur present is almost entirely in the form of sulphides when the waste is thrown out of the vats, and that by exposure to the atmosphere, the sulphides gradually become oxidised into hyposulphites, which are not acted upon by $MgCl_2$.

It is therefore essential that the vat waste should be used, and be taken from the vats to the decomposers, without loss of time, as, the fresher the vat waste used, the larger is the quantity of sulphur recoverable. Of the total sulphur in the vat waste, we have found that from 90 to 95 per cent. may be thus recovered, the balance, from 5 to 10 per cent., being lost, partly in the hyposulphites, &c., of the vat waste (which are not acted upon by the $MgCl_2$), and the remainder in the conversion of the H_2S into its commercial product. Great care, both in the construction of the plant and in the manipulation is, of course, essential, to guard against escapes of this highly dangerous and offensive gas, H_2S.

As $MgCl_2$ has not any action upon the undecomposed carbonate of lime present in the waste, the H_2S given off is *perfectly pure*, except as regards a certain quantity of steam, which is readily separated by means of condensation. The purity of the H_2S is one of the special features of this process, and contributes —as will be seen when we consider the third operation—in no small degree to its success.

The second operation, known as the carbonating process, by which the magnesium chloride is recovered, and carbonate of lime is obtained, is of the highest importance. It was in this operation that appeared to Mr. Weldon (to quote his own words) "the weak point in this very remarkable process," and to the impression left upon his mind by some experiments of a similar nature, made by himself, some eleven or twelve years ago, he attributes, in part, the fact that, although he brought it under the notice of many of the principal alkali makers in England, as Dr. Schaffner's representative, yet as "he could not tell them, either that Dr. Schaffner was himself performing the process on an industrial scale, or that he could regard the industrial practicability of this operation as being, as yet, absolutely established, none of them cared to do more than discuss the matter."

Nothing, therefore, was done in this country with this process, until, as already stated, we first learned of it from Lunge's book, and being in happy ignorance of Mr. Weldon's misgivings, we took steps to try it for ourselves. We failed at first to obtain satisfactory and complete results, in consequence of our power of pumping CO_2 being insufficient, but when we were able, by means of a powerful compressor, specially constructed for the purpose, by Messrs. Tangye, of Birmingham, to force CO_2 into the carbonators in a steady stream, *under pressure*, we found that this operation also was completely successful.

The carbonic acid gas used by us is supplied from a lime-kiln, heated by coke, the lime being used in our caustic soda process; the strength of the CO_2 gas thus obtained, varying from 15 to 23 per cent. As yet, we have not tried the flue gases from the black ash furnaces, but if the CO_2 thus produced is not too dilute, we hope eventually to use this source of CO_2 in this operation. The $MgCl_2$ thus recovered is used over and over again, but as the traces of soda left in the waste are converted into chloride of sodium, it will happen that each successive batch of recovered $MgCl_2$ will contain a little more of the NaCl so formed; a source of embarrassment, which, though slight and unimportant at first, will gradually have to be provided for. The carbonate of lime thrown down, is collected on filters, and carefully washed, in order to recover all the $MgCl_2$; these washings, being necessarily dilute, require to be concentrated by means of evaporation. The carbonate of lime itself will, to a large extent at least, be available for black ash mixings; not entirely, however, as some part may, for the present, have to be treated as a by-product, and be put aside, as it remains to be proved whether the impurities of silica, alumina, &c., &c., introduced by the black-ash operations, will not, as they accumulate, render the recovered carbonate unfit for mixing purposes.

To what full extent, therefore, the recovered carbonate of lime will be available for black-ash making is at present a mere matter of conjecture; perhaps it may be used four or five times, and the next batch have to be put aside, but this part of the process offers no serious obstacle to its success. My own thoughts turn in the direction of compressing the carbonate of lime thus put aside, which may not be pure enough for mixing purposes, into bricks, and then burning these bricks instead of limestone in the lime-kiln, thus obtaining the carbonic gas required, and selling the slightly impure lime so made to lime merchants, for building purposes.

The large towns of Liverpool, Newcastle, Glasgow, Birmingham and Bristol, which are in close proximity to the principal centres of the alkali trade, would seem to offer ample outlets for all the lime so produced, if it were not pure enough for chemical purposes.

The third operation deals with the H_2S given off in the decomposers, and converts it into commercial products. Messrs. Schaffner and Helbig propose to deal with it, by precipitating the S by the reaction, as already stated:—

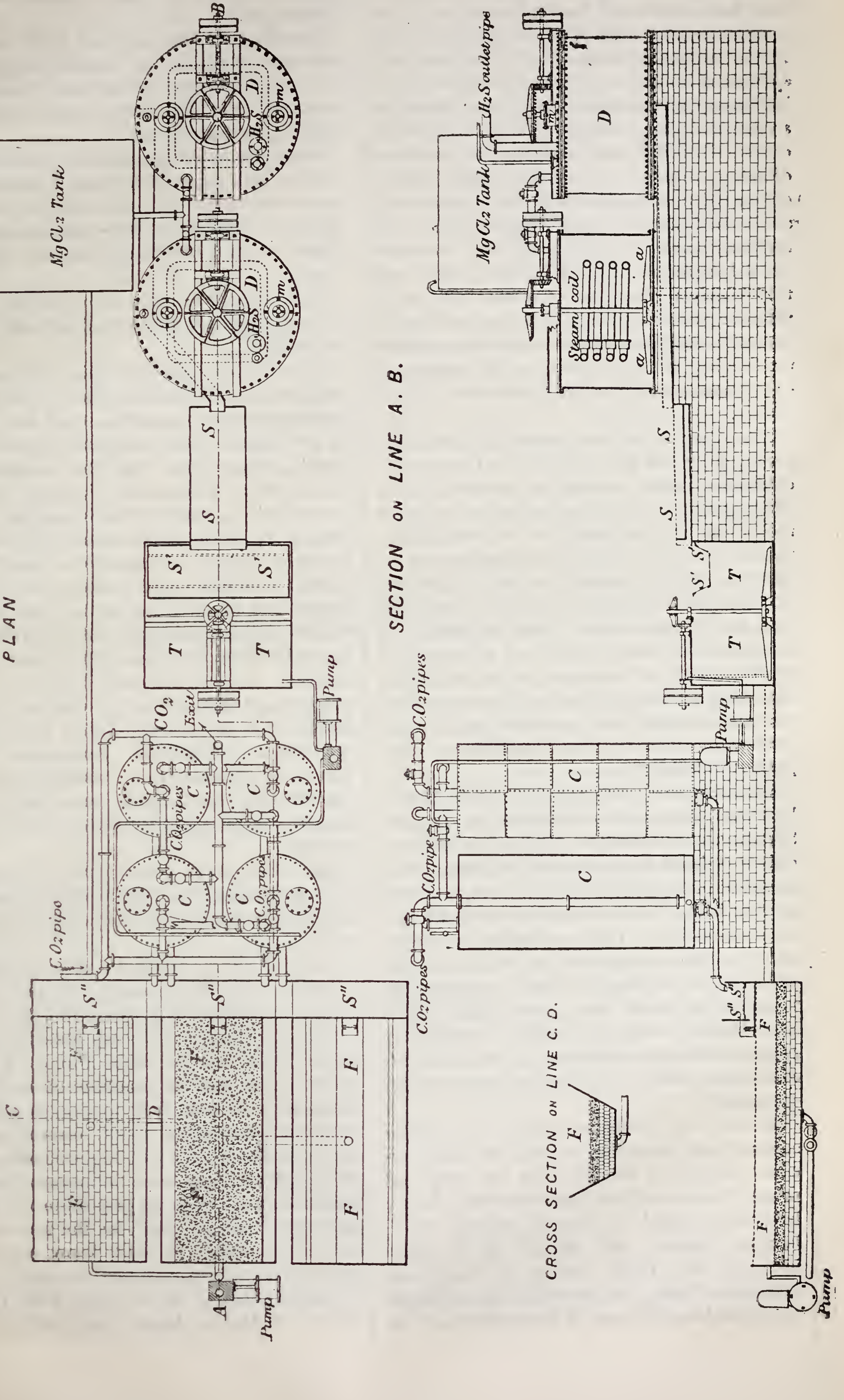
$$2H_2S + SO^2 = 3S + 2H_2O$$

This operation is fully described by Lunge, vol. ii. page 690, and the difficulties to be overcome, and the means by which the distinguished originators of this process overcame them are clearly set forth in the same volume, pages 645 to 648. Messrs. Schaffner and Helbig have proved that all the sulphur can be obtained in a granular, easily separable form, and without any loss by polythionic acids, if the gases are brought into contact, not with water, but with solutions of such salts as calcium chloride, magnesium chloride, sodium chloride, &c.

The operation just described has been successfully worked, on a manufacturing scale, at Dr. Schaffner's works at Aussig. We had hoped to have been honoured with Dr. Schaffner's presence here to-night, and to have heard from him further details of this very interesting process for extracting sulphur, as such, from H_2S. But in his absence, Mr. Weldon gives me to understand, that Dr. Schaffner recovered about two cwt. of free sulphur per day for about six months.

From the outset, however, of our own investigation of Messrs. Schaffner and Helbig's process, we were struck with the facility with which the *pure* H_2S, so produced, burns; and we, therefore, proceeded to try whether it might not thus be converted directly into sulphuric acid in vitriol chambers. The direct production of sulphuric acid by such means would, obviously, be very advantageous to alkali makers, who would thus recover from their alkali waste the sulphur in the very form in which they need it, besides dispensing with any large outlay for special plant. Having, at Oldbury, and, as we believe, for the first time, practically accomplished this operation on a large scale, it may be of interest to give some details of the process.

After the steam which is given off with the H_2S in the decomposer has been removed by means of cold water in a condensing apparatus,



EXPERIMENTAL PLANT FOR SCHAFFNER AND HELBIG'S SULPHUR RECOVERY PROCESS, AS WORKED AT THE ALKALI WORKS OF MESSRS. CHANCE BROTHERS, OLDBURY, NEAR BIRMINGHAM.

the dry H_2S is conveyed along a 4-inch cast-iron main, protected by hydraulic seals, to prevent the possibility of "lighting back," to a special burner, consisting of a cast-iron box, also water sealed, out of which a series of one-inch gas pipes pass into a brick oven, through a cast-iron plate, perforated for the admission of air. The H_2S gas is lighted as easily as ordinary coal-gas, and burns quite freely, giving off considerable heat, and producing, as is well known, by its combustion, just sufficient water for forming H_2SO_4, as shown by the equation, $H_2S + 4O = H_2SO_4$, and thus saving a great deal of steam. The nitre pots are placed in the flue at one or other of several potting doors, more or less distant from the burning gas, according to the increasing or decreasing supply of H_2S from the decomposers.

The oil of vitriol thus produced, is of great purity, quite free from arsenic, and upon concentration, yields rectified oil of vitriol fit for every purpose. We show samples to-night of this acid. So satisfied are we with these results, that we are making arrangements to burn the H_2S in connection with a Glover's tower, so as to derive the economy of nitre, of fuel, and of labour, due to that apparatus. If by a rough and ready burner, such as described, working only at intervals, we succeeded in obtaining satisfactory results, it seems certain that alkali makers will turn their attention, by preference, to this means of utilising the sulphuretted hydrogen.

We have now seen that the chemical combinations discovered and applied by Messrs. Schaffner and Helbig, do fully realise the conditions claimed for them by their distinguished inventors—that from 90 to 95 per cent. of the sulphur in the vat waste may be recovered in a commercial form; that practically the whole of the calcium compounds are also recovered, principally as carbonate of lime; and that the re-agent by which these remarkable results are obtained—namely, $MgCl_2$—is itself recovered, with the exception of the *unavoidable losses due to the manipulation of the process*.

In this last sentence lies the key to the success or to the failure of this beautiful process. $MgCl_2$ is valuable—far too costly at present to admit of any large measure of waste being disregarded. It may—it probably will—become cheaper and cheaper as its uses increase, and fresh sources of supply are brought to light; but meantime, its consumption must be minimised, if this process is to be adopted with all the bright prospects which it opens out.

You will therefore ask, and I will honestly endeavour to answer, as candidly as possible, the crucial question—What have these losses been, and what is the probable prospect of loss of $MgCl_2$ in this process?

But before entering upon this question and bringing this paper to a close, I must invite your attention for a few moments to the model submitted to-night of the experimental plant which we have ourselves been and still are using.

Let us now enter upon the consideration of the very important question of the unavoidable loss of $MgCl_2$.

So far as we have been able to determine, we have satisfied ourselves that chemically the combinations are complete, and that there do not appear to be any losses whatever of $MgCl_2$ except those due to manipulation. According to Lunge, vol. ii, page 695, the loss of $Mg\,Cl_2$, unavoidable in working on the large scale, is five or six per cent. Presumably, Professor Lunge obtained these figures from Messrs. Schaffner and Helbig, and if these figures can be shown to be the result of continuous working on a large scale, then the commercial success of this process is undoubtedly assured. For our own part, however, we are not, to-night, in a position to submit any actual figures as to the probable limits within which this loss can be confined. As pioneers of this process into England on a manufacturing scale, our attention has hitherto been chiefly, nay, almost exclusively, directed to two points, namely,

1st. The direct manufacture of sulphuric acid, by burning the H_2S in vitriol chambers, in which we have been completely successful; and

2nd. To the precipitation of the carbonate of lime, and the recovery, in the carbonators, of the $MgCl_2$ by means of CO_2.

This operation, as already stated, is found to be completely successful from a chemical point of view, and the reactions claimed for it in theory have been fully realised in practice. But our experimental plant, erected temporarily, and not with a view to permanency, has, as we fully expected, been the means of educating us, so that when we proceed to erect new and more extensive plant, for the treatment of our alkali waste, we shall know more precisely what to keep, and what to alter.

Several defects in our plant have caused losses of $MgCl_2$—losses thus solely due to mechanical causes—but these defects have, unfortunately, rendered worthless our results, as to the probable unavoidable loss of Mg Cl_2. The principal source of loss, however, has been due to our vacuum filters, and to our incomplete means of washing the carbonate of lime, which forms a precipitate so considerable in its moist state—exceeding in fact the bulk of the original vat waste itself—that a little $MgCl_2$ left behind in each ton would amount to a material total loss upon the whole quantity. Pressure filters, fitted with suitable washing apparatus, seem to offer the solution of this difficulty. During the last few days I have made inquiries from those who have had practical experience of filter presses, as to their probable value for this purpose, and from the information I have obtained, I entertain but little doubt that the use of filter presses will be crowned with success. The results of our last week's working—ending on Saturday, 6th May—are very encouraging. The loss of $MgCl_2$ amounted to 4·1 per cent., equal to 2 cwt. 1 qr. 22 lbs. per ton of S recovered, besides about 40 lbs. of calcined dolomite per ton of vat waste treated. But the analyses of several samples of the lime mud made last week, showed that nearly the whole of this 4·1 per cent. of the $MgCl_2$ was present in the lime mud, so that had filter presses been used, and the bulk of this $MgCl_2$ been thus recovered, our loss of magnesium would have been almost confined to the dolomite added to the carbonators.

This perfectly candid confession of our imperfect manipulation of this important portion of the process should not in any way deter others from embarking in it, as it will certainly not deter us from continuing to work upon it. At present we are busily engaged in doubling our plant, and in devising suitable filtering apparatus—the best possible proof of our opinion of the value of this most comprehensive method of dealing with alkali waste.

To the members of the Society of Chemical Industry, before whom, in London, Mr. Weldon first publicly directed general attention last January to this process, I promised, in the discussion which ensued, to submit the commercial results of our experiments—a promise which I look forward with much pleasure to fulfilling without any unnecessary delay. But for practical purposes and to be of any permanent value, figures of this kind should be based upon results obtained during an extended period, and from a sufficient quantity of material employed.

Meantime, the invitation which I had the honour, most unexpectedly, to receive from the Society of Arts, to read this paper to-night, has afforded an excellent opportunity, to many interested in this subject, to learn precisely what has been and what still remains to be done.

For my own part, I should much have preferred that one of the recognised leaders of the alkali trade had been in my place to-night, and I in his; but I am paying the penalty for the boldness which tempted me to try Messrs. Schaffner and Helbig's process, whilst others held aloof. The attractions of this beautiful process are still to me as great as ever. To recover, henceforth, at least nine-tenths of the sulphur now lost in the vat waste, instead of at most three-tenths, as had been occasionally recovered hitherto; to recover it without the use of any hydrochloric acid whatever; to become to this large extent independent of foreign sources of supply of sulphur; and to render the deposit of alkali waste no longer necessary, are advantages too substantial to be lightly disregarded in the present state of the alkali trade. Messrs. Schaffner and Helbig have opened up entirely new ground—have suggested entirely new possibilities. Their process may be, it probably will be, ere long, rendered more easily practicable by the further inventions of its illustrious authors themselves, and if Mr. Weldon, their distinguished representative in England, will disclose to us to-night the details of the more perfect process which he stated last January, was soon likely to be announced to the world by Messrs. Schaffner and Helbig, he will add yet one more to the many obligations under which he has placed alkali manufacturers, not only by his own remarkable inventions, but also by directing their attention to the inventions of eminent manufacturers abroad. As it is, the recovery of sulphur from alkali waste seems at last to be within a "measurable distance" of accomplishment, and to Messrs. Schaffner and Helbig belongs the credit of having originated the beautiful process which promises a new lease of life to the manufacture of alkali, as invented by Leblanc.

DISCUSSION.

The CHAIRMAN said when he consented, in the absence of Professor Abel, to take the chair, that he really quite forgot that he was Messrs. Schaffner and Helbig's representative in this country, or he should not so readily have assented. Inasmuch, however, as Mr. Chance had reminded them of the fact, he should like to be permitted, at this stage of the proceedings, to offer to Mr. Chance, on behalf of Messrs. Schaffner and Helbig, and also on his own, some expression of their sense of deep indebtedness to him for his enterprise in undertaking the experiments of which he had given so admirable an account; for the thorough manner in which those experiments had been conducted; and for the fulness with which he had stated the results, thus placing, at the service of all his fellow-members of the alkali trade the whole of his experience, with respect to this most interesting process, with that generous frankness which all those who were acquinted with him knew to be such a prominent element in his character. He only regretted that Dr. Schaffner was not present, to bear his own testimony on this point. He had fully intended to be present, but at the last moment he found it was imperative for him to be in Berlin on the next morning. From his position, which he held as representative of Dr. Schaffner, he should be unable, personally to take any part in the discussion, and he was not aware that he could give any additional information, except on one point, and that related to the use of flue gases and products of combustion, for the performance of the second operation. The experiments of Dr. Schaffner had been conducted mainly, and almost exclusively, with fuel gases. Those which he employed contained from 10 to 11 per cent. of CO_2, and he found that, in so doing the proportion of CO_2 absorbed was 34 per cent. when the pressure employed was 12 lbs. per square inch, and 36 per cent. with a pressure of 24 lbs. Taking the absorption at 33·3 per cent. they might say that the total quantity of gases to be pumped in the second operation, supposing them to contain 10 per cent. of CO_2, would be just 30 times the volume of the CO_2 actually absorbed. It seemed to him that the point most important to discuss was the practicability of using fuel gases, and those points relating to the appliances which it might be possible to use for filtering the carbonate of lime produced in the operation.

Mr. MACTEAR said Mr. Chance had so fully explained the process, that he could hardly throw any more light on it. He went to see the process, very much biased against it, believing that the weak point was in the recovery of the magnesia, and that that was a very weak point indeed. He spent some considerable time in examining the process from beginning to end, and he quite satisfied himself that that point offered no difficulty whatever. The idea that there was such a difficulty had arisen altogether from a misapprehension, and, as Mr. Chance had explained, from the fact that a small quantity of the magnesia had been removed in the insoluble matter, which kept back the conversion, until the addition of a small further quantity of magnesia, in the shape of dolomite, was made, which completely got over the difficulty, and made it as complete a success as the first portion of the operation. He should like to ask if Mr. Chance could tell them something more fully as to cost; but having gone into the matter as closely as he could, it appeared to him that this process was bound to be a success, and to be adopted by alkali manufacturers, unless one thing took place, and that was that the pyrites companies reduced their prices by 50 per cent. If they did that, and reduced the price to 3d. per unit, he was afraid Dr. Schaffner's process would have to wait a little for its development. But if that did not take place, there was no doubt, within the next year, a very large proportion of sulphuric acid used in the alkali manufacture would be made by this process, and he hoped himself to lend as much aid as he could to its development. Mr. Chance had asked him if he could throw some light on the utilisation of fuel gases, and in consequence he had made some experiments as to the amount of carbonic acid in the gases from the various furnaces. He found that it ranged from 8 per cent. upwards, and it occurred to him to ascertain the amount of carbonic acid in his own special salt-cake furnace which he had recently brought out. In that furnace they fired with gas, and, as a matter of course, they tried to burn it with the smallest quantity of air, the result being that, instead of having 8 per cent. or 10 per cent. of carbonic acid, they could get it up to 15, and even on certain occasions to 16 per cent. It seemed to him that was a very important point, because it showed that, given a certain amount of care and attention to other classes of furnaces, they ought to be able to increase very largely the amount of available carbonic acid in the fuel gases, simply by reducing the amount of air at present used for the combustion. That was a point to which all alkali manufacturers must direct their attention, to save fuel by reducing the amount of air passing the furnace. Looking back over Mr. Chance's statement, it would be seen that the point which had given him most trouble was the getting out the last traces of chloride of magnesium in the mud; at present he used vacuum filter beds; he had had a large experience in filtering presses, in dealing with substances quite analogous to this, viz., carbonate of manganese, which had to be dealt with by subsidence and decantation. It required a long time, and a large amount of plant, and left in the ultimate product a considerable quantity of chloride of calcium. Some six or seven years ago, he introduced into this process [a very well-known one, which, though it is now superseded by Mr. Weldon's, was in its day as great a success probably as that was now; and though it was now a thing of the past, it was one which they could always look back to as a most beautiful process] the use of filter presses, and by that means was enabled to dispense with an enormous amount of plant, to save at least 80 per cent. of time, and to reduce enormously the amount of chloride of calcium in the finished article. He was satisfied, therefore, that Mr. Chance would find, by the use of filter presses of the same or modified construction, that he would be able to reduce the amount of chloride of magnesium very largely, and would probably be able to wash it out to a mere decimal in per-centage. If that were the case, a great difficulty would be overcome. In conclusion, he must bear testimony to the fact that Mr. Chance had given him every facility for examining the process, and checking the different stages for himself. He believed honestly that this process was perfectly successful, even at the present moment, and it would necessitate either a reduction in the price of pyrites, or its adoption by alkali manufacturers, his firm for one having quite decided to adopt it at once to a considerable extent.

Mr. CAREY (Widnes) having had the pleasure of seeing this process in operation, could quite corroborate everything Mr. Chance had said about its success from a chemical point of view. The only point, as Mr. Chance said, was the fact that the actual cost was still more or less matter of speculation; but he thought Mr. Chance had gone far enough to show that that cost would not be very large. It might be 3d. per unit, or 2½d., or something of that kind, on the sulphur recovered; but although they did not know the actual cost, they could clearly see that it would not be at all large. In common with Mr. Mactear he felt perfectly confident that the process was practically, at the present moment, a success. He thought the furnace best adapted for giving good fuel gas was the ordinary black ash revolving furnace, for, however perfectly you could burn ordinary fuel, you did not get such a high per-centage of carbonic acid in an ordinary furnace as in the revolver, where you had not only the carbonic acid from the combustion of fuel, but the carbonic acid from the limestone in the charge. He had a table showing some experiments made a little time ago with their largest revolver, taking the gases from inside the neck next the revolver. They themselves used these fuel gases for a process they had, though in that case they took them, not from the part he was now speaking of, but from a part of the flue. which allowed of the dilution of the carbonic acid with a large quantity of air, so that it only contained 10 to 12 per cent.; they did so because they required oxygen as well as carbonic acid; but if pure carbonic acid were required, it could be taken before it got contaminated with air. From an average of nine experiments, he found that the average strength of carbonic acid from inside the neck was nearly 20 per cent. They had also made seven or eight experiments during a charge with the revolver, and found the per-centage varied during that charge, from 14½ up to 27 per cent ; the latter strength, however, only lasted a few minutes. With regard to washing the carbonate of lime, they had several filter-presses in constant use, and found they were much less formidable pieces of apparatus than persons who had looked at them for the first time would imagine. They got a large quantity of material, with very little wear and tear, or expenditure in labour, and he did not doubt that, with the use of filter-presses, Mr. Chance would be able to use the lime-mud with great success, and leave in it a very small fraction indeed of chloride of magnesium. The recovery of sulphur, with the hope of using it in the vitriol chamber, had long been a sort of will-o'-the-wisp in the alkali trade, which had lured many a good man to serious discomfiture, if not to ruin. Some few years ago, the late Mr. Gossage was applied to by a very well known inventor in the alkali trade, who wrote to him telling him he had been experimenting for the recovery of sulphur, and asked for his advice upon it. Mr. Gossage wrote back, saying he had recently lost a large sum of money in a similar attempt, and giving the advice to him that *Punch* did to those about to marry—"Don't." All that was now changed, and, through Messrs. Schaffner and Helbig's invention, and Mr. Chance's perseverance, it appeared as if they had a process which would certainly be successful.

Dr. HEWITT (Ratcliffe, near Manchester) said he must add his congratulations to those of previous speakers to Mr. Chance, for the able and patient way in which he had worked out this process. He did not think that any of the many processes which had been submitted to the alkali trade of late years was ever submitted to such an important meeting as that, or in such a perfect manner. Their experience was that they had had to risk a great deal, and he spoke as one of those who did risk something in adopting a process which was now working satisfactorily, taking all things into consideration; but in that process their early expectations were not justified by long experience. Many things they thought possible at first were found, on subsequent experience, not to be possible. He was referring to Deacon's process. At first they hoped that the amount of copper used would be very slight indeed, and though he was not prepared to say that it was a serious item in the cost of making bleach, still it was an item. They thought they could decompose a much larger per-centage of the total hydrochloric acid given off in the pot gas, than they found, on further experience, they could. Mr. Chance had used the term experimental plant, but that must not be taken to derogate from the plant which he had erected, but only to indicate that his mature experience enabled him to give them further advice, as was the case in every new process. It was evident that Mr. Chance approached this question with profound chemical and engineering knowledge, and he had applied that knowledge with extremely good effect. He said this after having seen the process, and also the limestone produced by it absolutely made into black ash balls, which, so far as the eye could judge, seemed to be as good as those made from ordinary limestone. Besides that, he had shown rectified vitriol, made free from arsenic and of beautiful colour, and sulphuretted hydrogen made into sulphuric acid, and told them of the total amount of sulphur recovered; he had been able to get from 90 to 95 per cent. into vitriol of the quality. He had not left much to do, but had perfected the process before he submitted it to the trade. That was a matter of extreme importance to them; he had shown the greatest frankness and conscientiousness in endeavouring to put before the whole trade every figure, after most careful verification. If he could find any fault at all, it was that Mr. Chance had been over anxious about the verification of his figures, because no practical man would think for a moment that figures of the important and exact nature which the diagram indicated, were to be obtained in the infancy of such a process. In asking him for certain additional information, he should of course only ask him to give it as far as he knew it, and not at all with the view of holding him responsible in any way for the figures. As a free trader, he was delighted that a method had been devised to rid the trade of what had become an oppressive monopoly. Owing to the action of free trade, unfortunately, they had had to submit, from excessive competition, to a continuous lowering of the prices obtained for the manufactured article, whilst, on the other hand, they were met with an extraordinary combination, with enormous capital, which said they must pay a certain price for the sulphur, and that was very inconvenient. He did not say a word against those gentlemen who had used their capital, and were endeavouring to obtain high dividends upon it; but he could not but congratulate the trade on the advent of a process which promised them a speedy riddance of their oppressor. Mr. Mactear said something about the wisdom of those gentlemen taking the thing in time, and reducing the price; as a chemist, with a great desire to prevent waste of any kind, he sincerely hoped they would keep the price up, because if they did it would furnish the most adequate motive for every one in the alkali trade to make good use of both the sulphur and calcium of his waste, and thus, that which had been a nuisance, and which of late had engaged the attention of a Royal Commission, and taken up the time of the House of Commons, would, instead of any longer being a source of nuisance, become an addional item in the national wealth. That was the sort of Free Trade he liked, which would enable them to cheapen manufacture without going abroad, and paying money for that which they could obtain for themselves. The great advantage of this process was, that it would enable them to make sulphur for themselves. It was a satisfactory thing for him, as a chemist and political economist, to see both the sulphur and calcium utilised in this way, especially as this process was one from which there was no waste product. He believed those who used the most perfect revolver for making black-ash balls would have even less waste than Mr. Chance referred to, for, by the use of a revolver, the amount of lime used could be reduced much more than it could be by any hand-furnace. He had not been able to reduce the amount of waste, even by M. Pechiney's process, with a hand-furnace, to anything like the same amount as he could with a revolver. He would ask Mr. Chance if he would throw a little further light on the same point Mr. Mactear had referred to, and especially if he had made any estimate of the cost of plant necessary to work this process; such an estimate as would enable them to judge what amount of labour and coal would be required. The only other matter which occurred to him to ask, was, whether Mr. Chance found in the manufacture of oil of vitriol by burning sulphuretted hydrogen, the amount of nitre used in the conversion of SO_2 into sulphuric acid was diminished or decreased. In conclusion, he must say that nothing gave him more pleasure than to observe this process at work. The process was absolutely of a laboratory character, and the regular way in which it went on, and the entire absence of anything like the indication of a chemical process, was especially remarkable, when it was remembered that they were dealing with such an offensive gas as sulphuretted hydrogen.

Mr. John Brock (Widnes) said a few days ago, by the kind courtesy of Mr. Chance, he had an opportunity of seeing this recovery process in operation, thoroughly examining each stage of it. He must confess he went there rather prejudiced against it, believing that the carbonating process was certainly the weak point, and was not likely to succeed. His opinion, however, had entirely changed on that point; he was perfectly satisfied that this was a thoroughly successful process, one which was going to emancipate them from what Dr. Hewitt had called a monopoly. They were greatly indebted to Mr. Chance for the way in which he had tried the various experiments, for these had been carried out on a scale by which trustworthy results were obtained. He was quite convinced in his own mind that this was the process of the future. In all previous processes, the highest amount of sulphur recovered had been about 30 per cent.; here they had a process by which 90 per cent. could be recovered, and with the recovery of the magnesia as chloride of magnesium, and the lime as carbonate of lime, the process was complete, although that carbonate of lime was not yet thoroughly available for black ash operations. He saw the black ash made with it, and it appeared to the eye equally good as that made from ordinary limestone, still it might be that, as the impurities increased with each operation, now and then a batch might have to be thrown aside, and a fresh batch of limestone taken, but that would not be a serious difficulty. He did not think the question of getting the carbonic-acid for fuel gases was going to be a difficulty either. It was pretty well known to manufacturers that if a furnace were worked by a fan, or a Koerting's blower, the fuel gases were very much richer in carbonic acid than when it was simply worked with a chimney draft. His friend M. Pechiney worked his hand-furnace by means of a fan, and he had in fuel gas 19 per cent. of carbonic acid. So that here was a source of carbonic acid at hand, which simply wanted the manipulation with regard to the admission of air into the furnace. He hoped that he should soon himself be making sulphur. He thought, from what he had heard, that sulphur would be recovered by this process, at 2½d. per unit, or perhaps 2d., but he should encourage every alkali maker to put down plant for recovering sulphur from his waste. Another strong inducement was, that you got rid of the intolerable nuisance arising from the waste, because, however carefully it was laid, there was always a certain amount of drainage which had to be dealt with in some way or other.

Mr. Cookson (Newcastle) said the operation wa extremely simple, and it was nearer 40 years than 30 since his firm first burnt sulphuretted hydrogen as a means of making sulphuric acid, and they had done it continuously since. They had never had any trouble whatever. Many people talked about the danger of it, and the fears of nuisance, but in neither respect had they ever suffered at all. He was not an alkali manufacturer, but in one of their processes they got sulphide of iron as a product, and, treating it with sulphuric acid, they obtained surphuretted hydrogen. This was taken direct from the still by a four-inch pipe, and burnt without any sub-division, or water-cells, or anything whatever between the still and the mouth of the pipe where it was burnt. An ordinary means of burning it was under a steam boiler, and they got as much steam from the boiler as supplied the chambers, and enough to spare to work the lifts. An alkali manufacturer would probably use it in a Glover's tower, or some such apparatus. Many Newcastle alkali manufacturers had seen the process, and would confirm his statement that, on going into the still-room, they did not know sulphuretted hydrogen was being made until he took out a plug, when they were soon satisfied of the fact, for a more simple process did not exist, or one more easily managed, and the danger of firing back was, he believed, quite visionary.

Mr. E. K. Muspratt, not having been able to avail himself of Mr. Chance's invitation to visit the works, could not speak of this process from practical experience, but he was sure that all must be convinced that, at any rate, a process had been found for the recovery of nearly the total quantity of sulphur which was used in the alkali manufacture. The main point of the process, after all, which made it a practical process, was that the sulphuretted hydrogen was burnt directly, and used for the production of the sulphuric acid. A good many people he had spoken to seemed to think the sulphuric acid would be used as Schaffner and Helbig proposed—for the production of sulphur—but if they would examine the figures given by Mr. Chance, of the imports of sulphur as compared with pyrites, it would be seen that they were only 40,000 tons as against 400,000, so that was not the direction in which the sulphur would be used. The examination showed that they would get three parts of sulphur to two of sulphide of hydrogen, which meant two of sulphide of calcium; and in order to get the three parts of sulphur, you had to use some source for producing sulphurous acid. By so doing, they would produce such an enormous quantity of sulphur that there would practically be no use for it—about 200,000 tons.

The Chairman thought Mr. Muspratt was under a slight misapprehension. The SO_2 proposed to be employed in recovering free sulphur, was produced by the combustion of part of the sulphuretted hydrogen obtained from the waste itself.

Mr. Muspratt said that in that case his estimate of 200,000 tons would be reduced by one-third. He had been under the impression that the process was really somewhat similar to Mr. Mactear's process for recovering sulphur, in which he burnt pyrites in order to get the sulphur; he did not think that was the practical method which would be employed by alkali manufacturers. There was no doubt that, if the price of sulphur and pyrites was reduced, this process would be adopted to a certain extent, in accordance with the third equation, and used for the production of sulphur instead of burning it as sulphuretted hydrogen in chambers, because, as they learnt from Mr. Brock and Mr. Mactear, the cost of sulphur by this method, and burnt directly, was likely to be about 2d. or 3d. If the Pyrites Company reduced their price to 3d. per unit, there would only be the inducement of getting rid of a nuisance, and the scientific perfection which Dr. Hewitt aspired after, to make this process attractive. There was no doubt the cost of plant must be something considerable, and in the present state of the alkali trade, he did not think any one would like to expend a large sum of money on new plant if he could really get his sulphur at a reasonable cost. He was not aware that the second part of the process had been carried to such perfection as it appeared to have been, though he was quite certain that the recovery of the magnesia would be rendered more effective by the use of filter presses. As regards the strength of carbonic acid in flues, he could quite corroborate what had been said by other gentlemen. Wherever pressure was used, whether by a Koerting blast or a Root's blower, a very much richer gas was obtained from the combustion of the fuel, for he had, for some years, a Koerting's jet blower to his salt-cake furnace, and the carbonic acid in the fuel-gas was 16 to 17 per cent., without any aid from limestone.

Mr. J. C. Stevenson, M.P., not having had the advantage of seeing this process in active operation, could only make a few general remarks upon it. It was evident that Mr. Chance had not been too hasty in bringing this forward, but had waited patiently until he could show some substantial result, and had come forward at the most opportune time, when the trade was suffering from long continued and unexampled depression. They were pressed by the ammonia process, in which the use of sulphur was not required at all, and anything which enabled the old Leblanc process to compete with this new rival must be heartily welcomed by all. The results already laid before them were most encouraging, but it would be interesting to know how far the process was applicable to the recovery of nitre by Mr. Glover's process. He could not help saying, with regard to Glover's tower, that there was no invention connected with the trade in recent times that had been so meritorious and valuable as that. It would be interesting to see how far the sulphuretted hydrogen burnt in this way would be applicable to the recovery of nitre by the Glover's tower, and he saw no reason why it should not be so applied. This was one of those points on which further experience was required; the process was only in its infancy, and if the results now shown had been achieved in so small a number of months, they might look forward with the greatest hopefulness to their being able to recover nearly all the sulphur which had hitherto been utterly wanted.

Colonel GAMBLE agreed with previous speakers that there was no difficulty whatever in burning sulphurretted hydrogen to manufacture sulphuric acid, It was carried on in at least four works in Lancashire in 1839, and in some of them five or six years afterwards, the sulphuretted hydrogen being produced by Gossage's process. The gas was burnt in two three-inch pipes in which, in the first place, there were holes perforated about $\frac{1}{4}$ inch in diameter, but afterwards, they were simply left open at the end, and the gas was fonnd to burn perfectly well. The pipes were placed in a vault, perhaps, four feet wide and five feet long, covered with a perforated arch, over which a tower, five feet high, was built filled with brick-bats, so that any sulphuretted hydrogen which escaped from the pipes unburnt should be consumed in the mass of red-hot bricks above. Of course, the whole of the magnesia could not be expected to be recovered in washing, but he observed that the greater portion of that left behind appeared by the analysis to be either carbonate or oxide, and he did not see how they could expect to prevent that by any improvement in filtering. He did not know how far that might arise from the addition of the dolomite.

Mr. CHANCE said it arose entirely from that cause.

Mr. GLOVER desired to express his admiration for Mr. Chance's generosity. He would not detain the meeting with any comments on the process which had been so well worked, except in one direction. They had heard a good deal as to how best to recover the sulphur, and the preference appeared to be given to burning the sulphuretted hydrogen to produce sulphuric acid. In his opinion, that would be found a complete and total failure. During a lengthened experience, he had burnt a large quantity of sulphuretted hydrogen of the purest kind obtained from the decomposition of a metallic ore, with hydrochloric acid, and the economical results, after many years' patient experimenting, were most disappointing. Two gentlemen had spoken of their success in burning sulphuretted hydrogen, and no doubt it appeared to burn beautifully. The combustion certainly appeared to be clear, the flame blue, and so far as ocular demonstration went, there appeared to be complete success. He did not know what Mr. Gamble had done, but he had seen what Mr. Cookson had done, and that gentleman was burning sulphuretted hydrogen under conditions which would not give him any chance of judging of the results. A few weeks ago he saw the process; it was burning sulphuretted hydrogen in conjunction with the combustion of pyrites, and in such small proportion that it must have produced a very small proportion of the sulphuric acid which might be obtained from the pyrites. This process was a very beautiful one, but he thought sulphur would have to be recovered in the pure form, and most of it would go to those who required pure sulphur, thus taking the place of pyrites. They knew that by the injection of sulphuretted hydrogen into solution of chloride of calcium or magnesium, along with sulphurous acid you got precipitation of the whole of the sulphur, and that in a form in which it was easily handled, and was absolutely pure. He mentioned this, that those who were going to experiment might turn their attention in this direction, for he was quite certain the combustion of sulphuretted hydrogen in atmospheric air would produce along with sulphuric acid such a large amount of pentathionic acid, that the economical result would be disappointing. It had been said that the sulphur would cost about 2½d. or 3d., but he did not think it should cost anything of the kind. Although a considerable amount of labour was evolved in working this apparatus, the same thing occurred with regard to pyrites, so that he should not be surprised if as the process developed the expense of working such a plant would be greater than that of working a pyrites still.

Mr. CHANCE, in reply, said that the motto for the day, in the *Poet's Almanac*, was, "He is most free from danger who, even when safe, is on his guard," and he meant to be on his guard with respect to being drawn out as to the cost of plant, and other figures, because he distinctly stated in the paper, and now repeated it, that to be of any value, figures of this kind should be obtained over a sufficiently long period, and from a large quantity of material operated upon. At the same time, he would not shirk the question altogether. With regard to making sulphuric acid from sulphuretted hydrogen, Mr. Glover might be right, and he might be wrong, but his own experiments, conducted with the greatest care for several weeks, had shown that they did obtain from 90 to 95 per cent. of the sulphur in vitriol chambers, kept distinct and apart for that special operation. But it was of considerable advantage to the future of this process, that there should be alternative operations, so that one who might have greater skill in obtaining sulphur in the way Dr. Schaffner obtained it might use that method, and another who, by a happy combination of circumstances, worked as successfully as Mr. Cookson and

Fig. 8.

CONSTANT & INTERMITTENT WATER SUPPLY, LIVERPOOL.

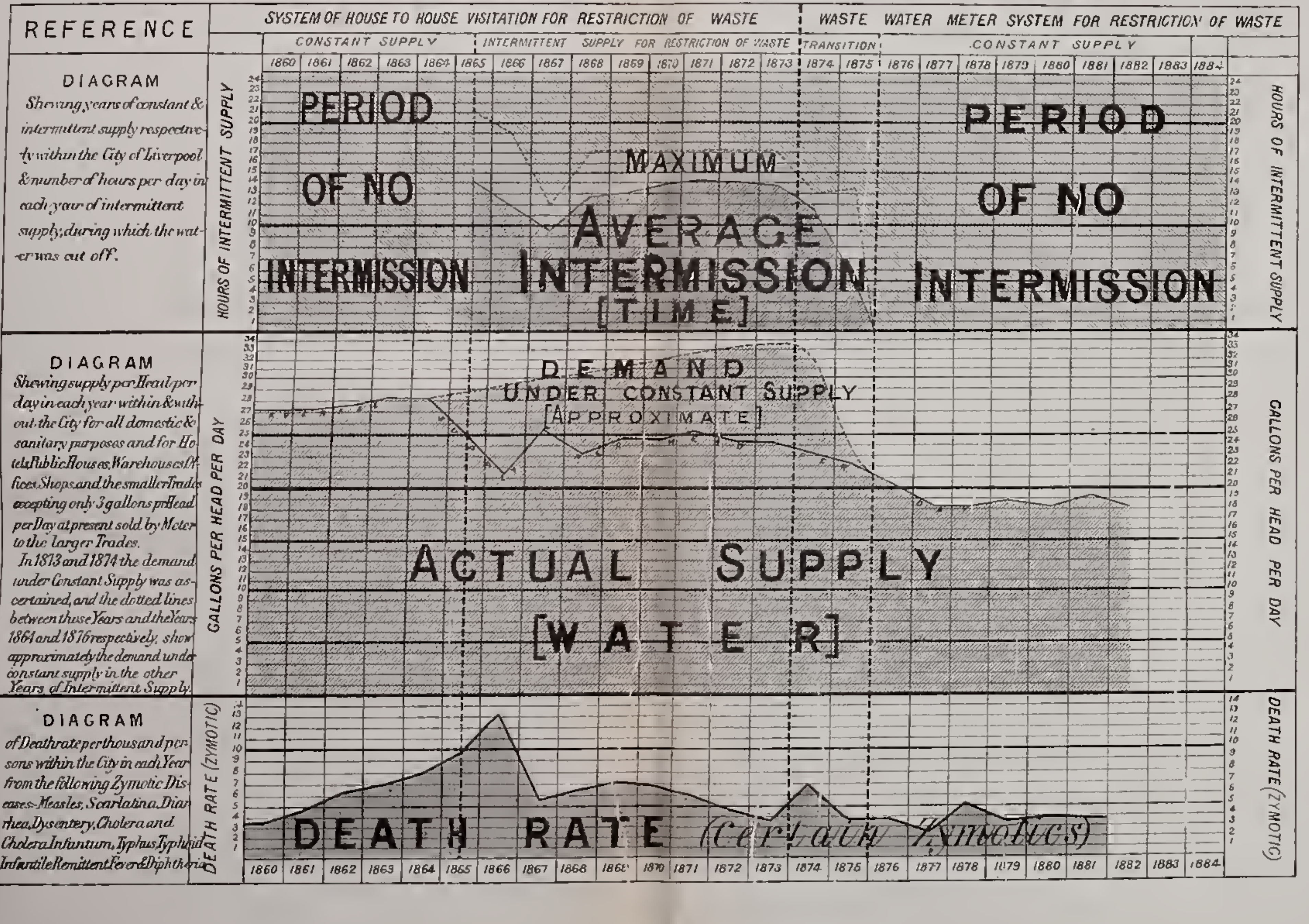


DIAGRAM
Shewing years of constant & intermittent supply respectively within the City of Liverpool & number of hours per day in each year of intermittent supply, during which the water was cut off.

DIAGRAM
Shewing supply per Head per day in each year within & without the City for all domestic & sanitary purposes and for Hotels, Public Houses, Warehouses, Offices, Shops, and the smaller Trades, excepting only 3 gallons pr Head per Day at present sold by Meter to the larger Trades.
In 1873 and 1874 the demand under Constant Supply was ascertained, and the dotted lines between those Years and the Years 1864 and 1876 respectively, show approximately the demand under constant supply in the other Years of Intermittent Supply.

DIAGRAM
of Deathrate per thousand persons within the City in each Year from the following Zymotic Diseases—Measles, Scarlatina, Diarrhea, Dysentery, Cholera and Cholera Infantum, Typhus, Typhoid, Infantile Remittent Fever & Diphtheria.

Fig. 3. **LONDON** LAMBETH WATER Cº Example of a Waste Water Meter Diagram April 1882, from a District of 1,256 Persons, showing a partial night inspection, commenced at 6.25 a.m. being the first after the fixing of the Meter

WASTE	GALLONS
Total per hour	4350
Total per head per day	83

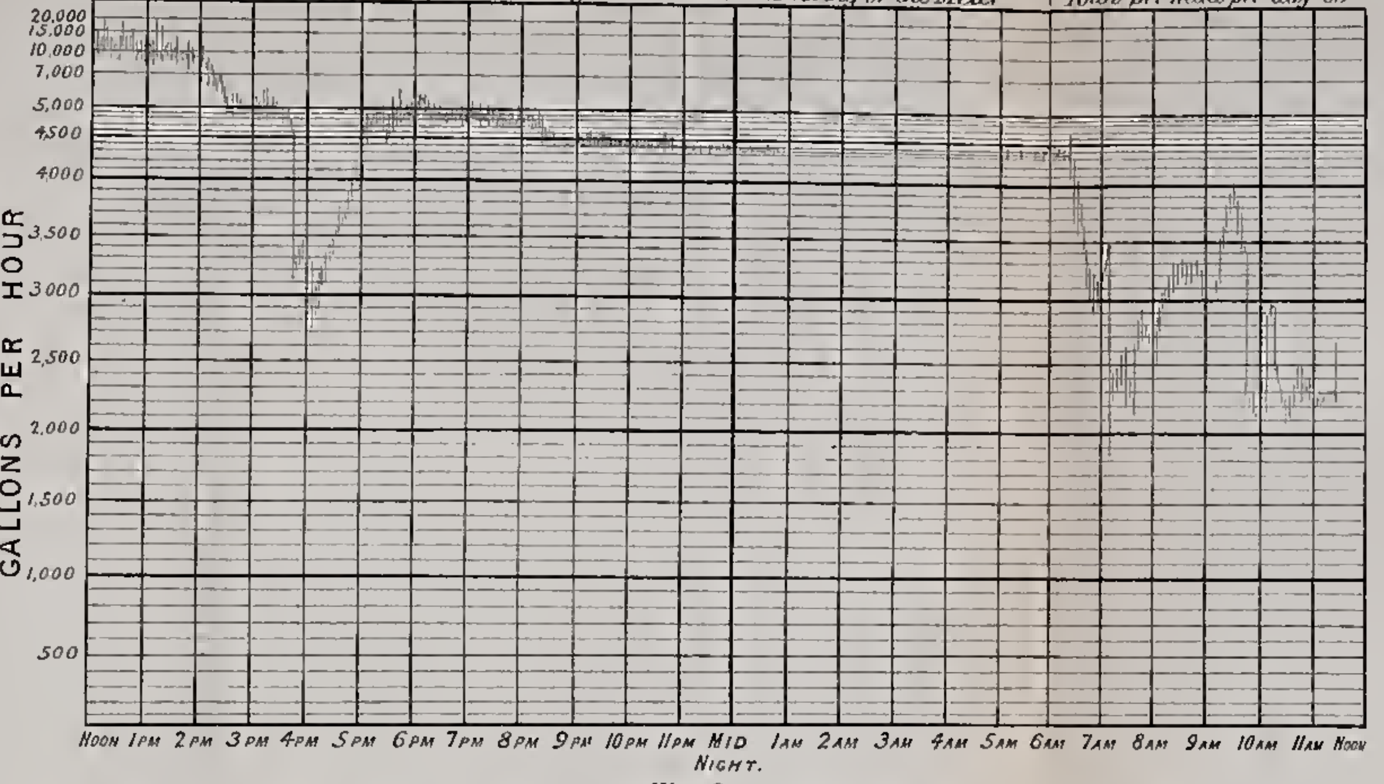


Fig. 2.

WASTE WATER METER Cº LIMITED LIVERPOOL. DIAGRAM FOR FOUR-INCH METER.

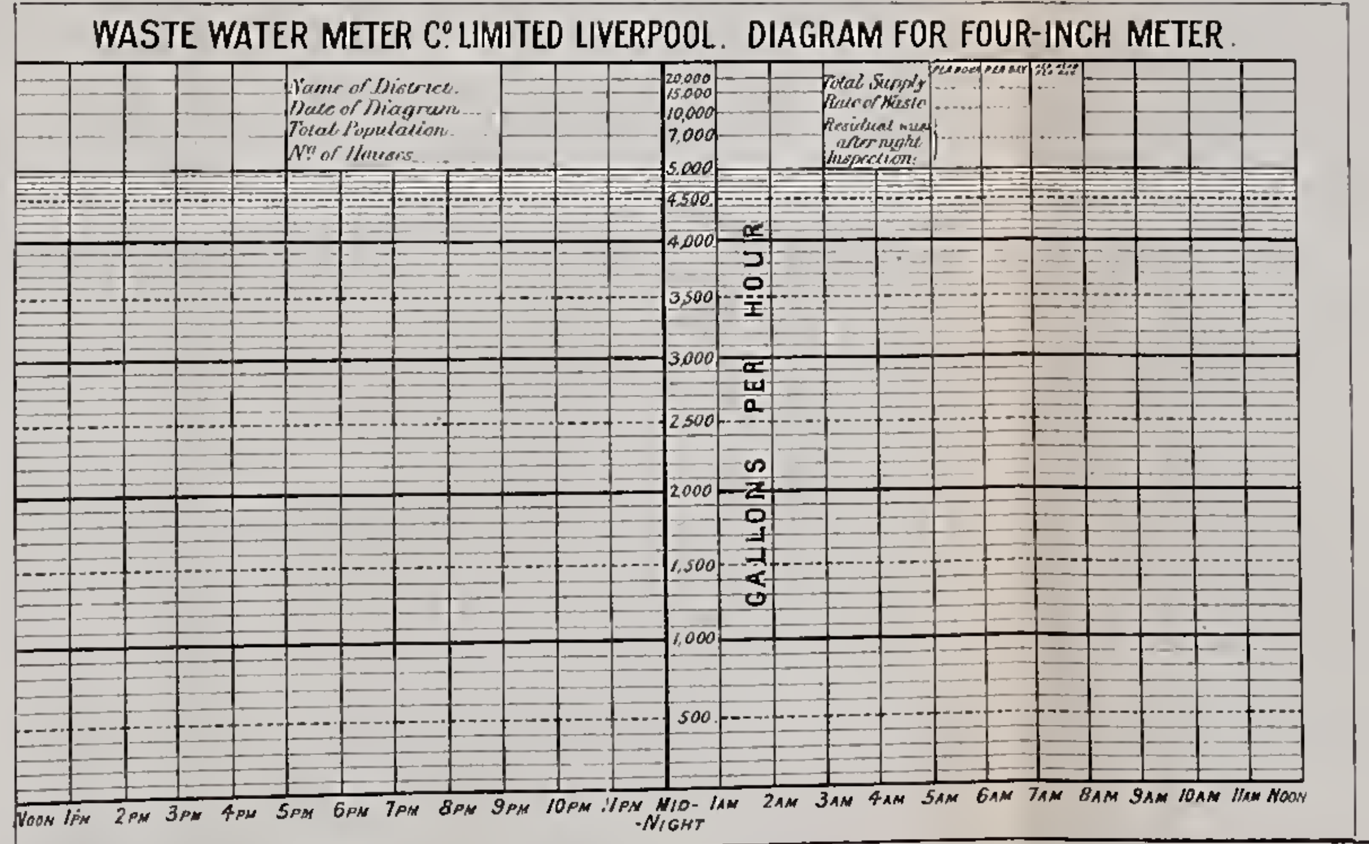
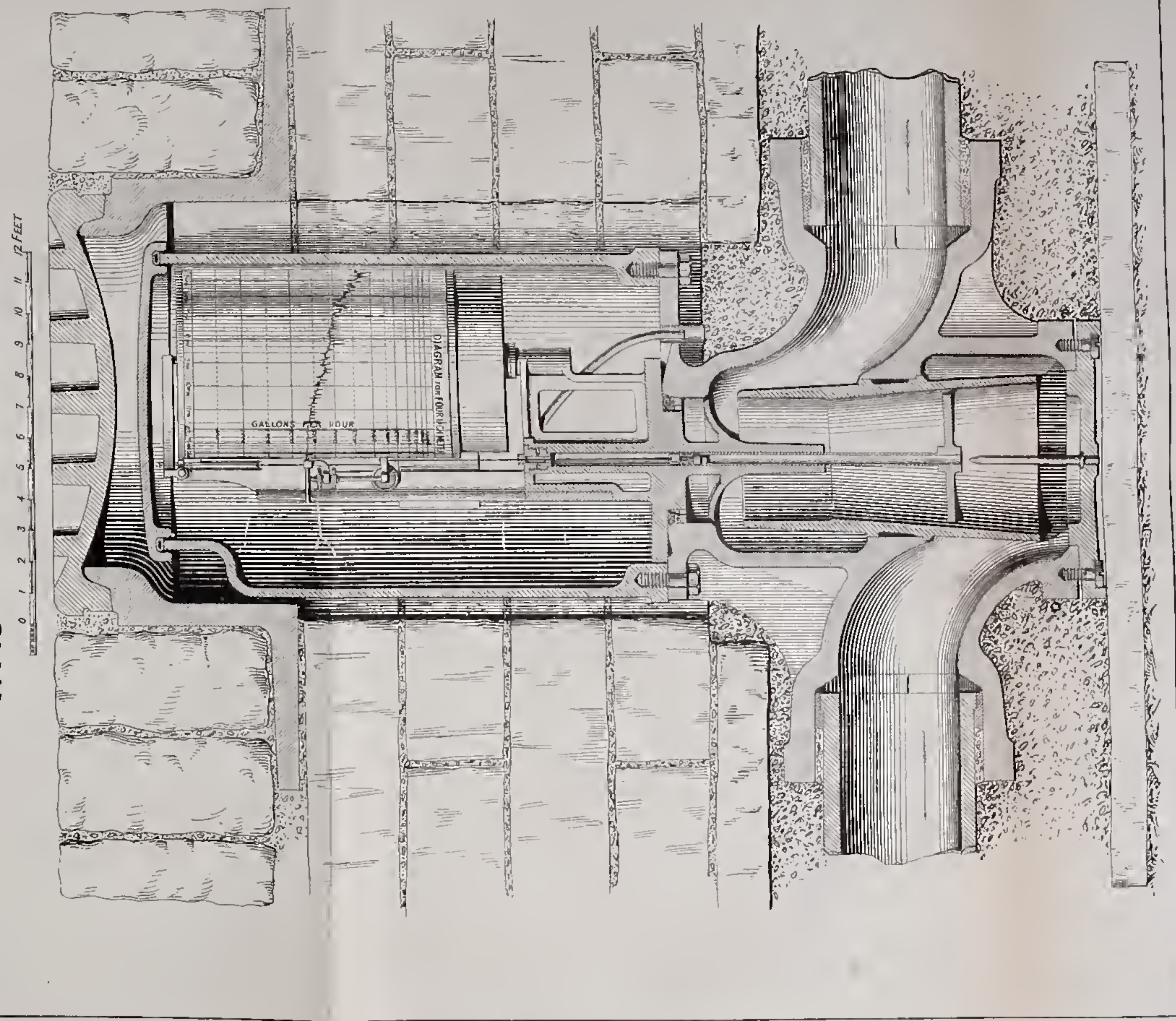


Fig. 9.

WASTE WATER METER.



A.S. CATTELL & Cº LITH. LONDON

others appeared to have done, might convert the H_2S into sulphuric acid. There was no doubt that the operation of burning it would be greatly facilitated by the fact that the sulphuretted hydrogen in this case was given off in a state of perfect purity. With regard to what Colonel Gamble had said, so far as they had been able to ascertain, the quantities of carbonate and oxide of magnesium appeared to be due to the addition of dolomite. In some cases they might have added too much, but they had every reason to believe that dolomite might be added, eventually, in almost the proportion to replace the MgO lost. As the process was worked with more care, it was probable they would be able to eliminate the coke and limestone before it went into the decomposer at all, instead of later, when an appreciable source of loss would be got rid of. Mr. Cookson had spoken of his long experience in burning H_2S, and he might say that he learnt last week for the first time from Mr. Weldon, that Mr. Cookson had been burning sulphuretted hydrogen in the way described; and when he said in the paper that he believed they had for the first time employed it in this way, he referred not to the manufacture of vitriol from sulphuretted hydrogen, but to the manufacture successfully of vitriol from vat waste; and he had asked the Chairman to call on Mr. Cookson, because he thought his testimony would strengthen their own experience, especially as to there being no danger to the workmen. Mr. Mactear had hazarded an opinion as to the probable cost of the sulphur recovered by this process; but he must remind the meeting that he had not yet said a syllable as to what he believed would be the cost. With regard to the quantity of nitre for the sulphuretted hydrogen burnt, he would give the figure; but it must be taken with some caution, as it was only derived from the working of one week, and on such a point the question of stock might have a great influence on one week's operations, when it would not if spread over several months. The amount of nitre used to sulphur burnt, was 5·46 per cent, which was exceedingly satisfactory, but he intended to choose his own time for submitting the further figures to members of the Society of Chemical Industry, before whom a paper was first read on this subject by Mr. Weldon. With regard to the cost of plant, he based his calculations on a decomposition of 300 tons of salt cake a week. The decomposers worked off 2½ tons every eight hours, or 7½ tons of vat waste every twenty-four hours, but his impression was, they would soon find means of expediting the decomposition, for it dragged for the last four hours in a way that should not require a vast amount of brains to overcome. But, taking the basis of eight hours, as at present carried on, his own views were, they would require fourteen of these decomposers, and a corresponding plant of carbonators and filters. He estimated each decomposer would cost about £100, making £1,400 altogether, and he suggested they should be raised as high as possible, in order to turn to account the advantages of gravitation. A revolving sifter might be adopted, which would save labour. Mr. Mactear had asked him for an approximate estimate of the cost of sulphur recovered by this process, which he would now give. Those who had seen the figures had blamed him for erring on the side of caution, but that was the only safe side on which to err. Taking as a basis 300 tons of salt cake decomposed per week, that was equal, in good works, to 150 tons of pyrites used, as each ton of Spanish pyrites ought to give two tons of salt cake, with careful working. About 85 per cent. of the sulphur passed into the alkali waste, the other 15 per cent. being lost in making the sulphuric acid for decomposing the salt into sulphate, and the sulphate into black ash. Of the 85 per cent. which got into the vat waste, he took 90 per cent. as his estimate. and with that he took into consideration two-thirds of the limestone recovered. He did not take that at the high price they had to pay at Oldbury, but put it down at the lower price of materials ruling in Lancashire. For the assets then, he took pyrites which would be used in making the salt cake, plus the value of a certain proportion of limestone recovered, plus a certain set-off with regard to the economy in deposit of waste, which in many districts was a great burden on the trade. Then, on the other side, labour would not be a large item, provided gravitation were utilized, and the plant were sufficiently large; but coal was an item which Mr. Glover and Mr. Weldon had apparently overlooked. The evaporation of the weakened recovered chloride of magnesium should undoubtedly be borne in mind. Then there was the loss of chloride of magnesium, which he took at 6 per cent., as given by Lunge, though, after what Mr. Muspratt and others had said in regard to filter presses, he had most sanguine hopes that a large reduction would take place in that figure. Then there was a certain amount for hauling. With regard to the outlay, he took the plant at £8,500 for this quantity of 300 tons per week. They had the advantage at Oldbury of the services of an exceedingly able staff, and Mr. France, who had entered most heartily into this experiment, thought that this figure was rather too high, and that it might be put at £7,000, but he preferred to be on the safe side. Then he wrote off 10 per cent. per annum for interest and depreciation, and 10 per cent. per annum for repairs. Then came the question of royalty. They paid nothing, and that was the only advantage they had; but he was afraid Mr. Weldon and Dr. Schaffner were going to ask rather too large a sum. He did not think they ought to ask more than 1s. per ton of salt cake decomposed, and on that figure he based his calculation. The whole figures taken together gave the outlay which would be required for obtaining the assets on the other side. He believed Mr. Tennant, at the Merchants'-hall, at Glasgow, said that, from a variety of causes, mainly from the extension of the ammonia process and the adoption of a sulphur recovery process, the consumption of pyrites was not unlikely to suffer serious diminution; and he went on to state that, in his view, a reduction in price appeared to him wise. Now, it appeared to him (Mr. Chance) that if they had bought up Schaffner and Helbig altogether, they, from their point of view, would have done the wisest thing they could. In view of those remarks by Mr. Tennant, he wrote to Mr. Tennant's firm, and asked them to allow a member of their staff to come and help him to check his figures, and suggested that Mr. Mactear should come and see the process. They sent a member of the staff for a week, who checked all the figures, and with regard to the cost sheet now under consideration, Mr. Mactear was good enough to go through the figures, and wherever they varied he had adopted those of Mr. Mactear. The opinion had been hazarded that sulphur could be obtained for 2d. per unit. He thought they had better take the figures as a reduction of 2d. and two-thirds per unit on the present price of pyrites. Thus, if they were paying 6d. per unit for pyrites it would be 3⅓d. That was his approximate estimate, but it left the net result that for a capital expenditure or £8,500 there appeared to be a probable return of £4,000 a year.

The CHAIRMAN congratulated the meeting on the exceptionally interesting paper, and the very valuable discussion which it had elicited, and proposed a hearty vote of thanks to Mr. Chance, which was carried unanimously.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 17th, 1882; Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, in the chair.

The following Candidates were proposed for election as Members of the Society:—

Beckingham, James Horace, 48, Percy-park, Tynemouth.
Bright, Thomas Smith, Glannant, Carmarthen.
Buchanan, John, 4, Windsor-crescent, Newcastle-on-Tyne.
Cooper, Henry, 20, Moor-street, Soho-square, W.
Morris, William, 2, Westminster-chambers, S.W., and Greenock.
Searchfield, Charles, Merchants' College, Claremont-park, Blackpool.
Wells, Rev. Edward, B.A., Flamstead Vicarage, Dunstable, Bedfordshire.

The following candidates were balloted for and duly elected members of the Society:—

Carter, George, Manchester and Salford Bank, Southport.
Everitt, William E., Finstall, Bromsgrove, near Birmingham.
Gamble, Lieut.-Colonel David, Windlehurst, St. Helens, Lancashire.
Howell, Samuel Earnshaw, Brook Steel Works, Sheffield.
Kershaw, John, 1, Arlington-street, Piccadilly, S.W.
Little, George, Werneth-lodge, Oldham.
Lloyd, Charles, 167, Howard-place, Shelton, Stoke-on-Trent.
Lloyd, Francis Henry, Wood-green, Wednesbury.
Penny, Colonel, R.E., Bineleaves, Weymouth, and East India United Service Club, S.W.
Scott, William, 1, Southwick-crescent, Hyde-park, W.
Teetgen, William, Lea-view, Mount Pleasant-lane, Upper Clapton, E.

The paper read was—

THE CONSTANT SUPPLY AND WASTE OF WATER.

By GEORGE F. DEACON, M.Inst. C.E.

Of all useful things produced or supplied by art, water is undoubtedly the cheapest. When pumped from the earth, or collected from distant mountains, conveyed by costly engineering works, distributed through a town, and delivered at the houses of the people, it is paid for at the rate of about three half-pence per ton. No wonder, therefore, that to a casual observer, the quantity used or wasted should be considered unimportant. But I hope, before concluding this paper, to satisfy you that the waste of water is an evil of the highest importance, and one, happily, that may be prevented at a comparatively insignificant cost; and if, in the course of doing so, I dwell for some time upon matters which must appear to many of you to be truisms, I must beg your indulgence, in consideration of the fact that the rudiments of the subject are certainly not generally understood.

When the waste of water is spoken of, it is often associated with unnecessary use, or rather, as I should, perhaps, say, with waste in the modes of use; but this is by no means what is meant. Let it be granted that every householder in a community has as many taps, baths, and water-closets as he desires; that there is no restriction whatever to the quantity of water he may draw; that his servants are duly careless, and that water, under considerable pressure, is always found, by night, as well as by day, when a tap is turned. In the term waste of water, I include none of the water under such circumstances, used or unused, so that if the whole waste referred to were entirely prevented, the use and misuse of water would still proceed with impunity in every household. The prevention of the waste of water, therefore, is not in any sense, a restriction of the use or misuse of water, but, as I hope to show you this evening, may even conduce to the greater use or misuse, by rendering the water more readily available, under high pressure, and at all times. Not that misuse is a good thing, but that absolute absence of restriction is, I think, a good thing. It would be better to allow a gallon to be misused, even if there were the power—which there is not—to prevent it, than to restrict the proper employment of a pint.

Having thus explained what the waste of water is not, it is desirable to explain what in the sense in which I use the words, it is. It is, then, any loss whatever between the point where the water enters the town and the taps or other domestic water-fittings. It includes leakage from leading mains undergound, generally small in quantity; it includes leakage from distributing mains, underground, often considerable in quantity; it includes leakage from house service or communication pipes underground, and from their connections with the distributing mains, often great in quantity; and it includes leakage from the distributing pipes about a house and from the fittings.

Obviously, this waste may be broadly divided into two parts.

The first we will call invisible waste, being generally underground, and always incapable of detection by superficial examination.

The second, we will call visible waste, being generally above ground, and otherwise capable of detection by superficial examination.

Now, it will be readily understood, that the loss from invisible waste is, under ordinary circumstances, very rarely detected, unless the amount of waste is so great as to impoverish the supply to neighbouring houses beyond the limits of endurance. In the case of visible waste, however, generally caused by defective house-fittings, the conditions are essentially different. That such fittings are subject to deterioration, most of us know by unhappy experience, and until the nuisance created by their leakage becomes intolerable, we often allow the waste to continue; but, sooner or later, the plumber is called in, and repairs of some kind are effected. As compared with the hidden waste, therefore, individual cases of such superficial waste are of a more or less intermittent character. So, therefore, the continuous waste, which we can imagine, and the aggregate of intermittent leaks, which we see, amount, we are ready to believe, to a certain fraction of the whole supply. Take the case of a £40 householder, with his wife, three children, and one servant, six persons in all; if he draws on an average, 15 gallons per day for each person, that is 90 gallons per day in all, he is a very large consumer of water indeed; but if, in any part of his premises, above or below ground, there is a leak no larger than the diameter of a moderate-sized sewing needle, discharging water continuously under a pressure of 45 lbs. per square inch, his share of the water supply is at once doubled, and if the needle-leak were stopped, two houses instead of one could be supplied. The aggregate sectional area of 1,634 such needles is one square inch. By means which I shall explain, it has been ascertained that such invisible leaks are exceedingly common, and that they vary in size from the sewing-needle, or even less, to the square inch, or even more, in which last case, the single leak, under the assumed pressure of 45 lbs. per square inch, would supply, probably, 1,200 such households, or 7,200 persons. It by no means follows, however, that because a pipe contains such defects it is insufficiently strong in other parts; whether it is so or not is readily ascertained when the leak is exposed. On the table are many such underground defects, taken from hundreds of others, detected in different places by the method which I shall have occasion to describe.

Such then is the nature of the leaks producing the invisible defects referred to. Their number, although in the aggregate large, is generally small as compared with the number of leaks from domestic fittings, causing visible waste, but, owing to their much greater average size, and often also to the much greater pressure under which the water flows through them, the total waste from these invisible defects often greatly exceeds the total waste from visible defects.

To fix the ideas, the typical diagram, Fig. 1, has been prepared. It is simply a graphic description of a case commonly met with in practice, and represents the flow of water through a water main supplying a district of 1,933 persons. The area of the diagram is divided, by vertical lines, into 24 hours, and by horizontal lines into gallons per hour.

In the district in question, the invisible defects cause a waste of 800 gallons an hour, or 9·9 gallons per head per day. This flow is, of necessity, perfectly uniform from instant to instant, and is therefore properly represented by the lower rectangle, crossed from right to left. The length of that rectangle is 24 hours, and its breadth 800 gallons an hour.

Besides the invisible waste thus graphically represented, there is a loss from more or less visible defects, chiefly in house fittings, causing a uniform flow of 400 gallons an hour, or 5 gallons per head per day; and this waste is correctly represented by the upper rectangle, crossed from left to right. The two rectangles taken together represent a total waste of 1,200 gallons an hour, or 14·9 gallons per head per day.

Now, although the water wasted by invisible defects in any given supply can thus be represented by a rectangle, because its flow is nearly constant from hour to hour, and minute to minute; and, although the aggregate of that wasted by visible defects can, for similar reasons, be similarly represented, it is obvious that the water which is drawn off for use cannot be similarly represented. The flow of water for use can never be constant. In the district in question, for example, the inmates of 360 houses are drawing water by taps and valves, more or less frequently. Suppose, for example, that a single tap is opened, and left open for five minutes, during which time water flows through it at the rate of 480 gallons an hour, so that the actual quantity passed is $\frac{480}{12} = 40$ gallons. If there were no cistern between the tap and the public water-main, the diagram representing the flow in the main would still be a rectangle, as shown from 3.32 to 3.37 a.m.; but if a cistern intervened, the diagram would have the figure shown between 4.17 and 4.32 a.m. Here the first effect of opening the tap is to open the cistern ball-cock, at the end of five minutes, to the rate of 150 gallons an hour, and then gradually to shut off the water until—when the 40 gallons drawn from the cistern have been replaced—the flow entirely ceases.

By three classes of figures and their combinations, we can therefore represent all the modes of flow which occur in practice.

The first mode of flow, constant in velocity, and long in duration, representing the two classes of waste, invisible and visible, and shown by the lower and upper rectangles respectively.

The second mode of flow, also constant in velocity, but of comparatively short duration, representing the draught of water through a tap, without a cistern between it and the water main.

The third mode of flow, varying in intensity, quickly attaining its maximum, but slowly diminishing, caused by the passage of water through a ball-cock into a cistern.

Now, if we take any ordinary case of water supply, we find that these three modes of flow co-exist, and their resultant from noon on one day to noon on the following day, is distinctly shown from minute to minute, by the position of the upper horizontal line on the diagram. It tells us, from noon till about 10.50 p.m., a story of constant waste at the rate of 1,200 gallons an hour, and of almost constant, but variable use, or misuse, added to that waste. It tells us, after 10.50 p.m., the same story of continuous waste and of less continuous use, and from that time till 4 a.m. it tells a further story of ball-cocks gradually closing, and cisterns steadily filling up. From 4 a.m. to 4.45 a.m., it tells us, by the perfectly horizontal line, of a constant flow to pure waste, only broken by two draughts direct from the main, and by three small draughts from cisterns. And at 5 a.m. it tells us, by occasional draughts of water, of early risers, and later, of the busy world once more. And here I would observe, that the horizontal line is the proper representative of waste, and waste only; not because it occurs during the night, but because it is uniform and horizontal, and because, as you have seen, the smallest quantity of water drawn for use or misuse instantly alters its character.

I have hitherto spoken of this diagram as a theoretical representation of what must occur in a water main supplying a district; but in the sequel, I shall have occasion to show you that such a diagram may be automatically reproduced by the motion of the water entering any district through the main supplying that district, and that the facts thus made known to us lead to important results.

The volume of water shown by the diagram to be wasted is, as already stated, 1,200 gallons an hour, equal to 14·9 gallons per head per day. The total supply is easily ascertained by drawing a mean line to be 29·7 gallons per head per day. The difference 14·8 gallons per head per day is the volume actually used or misused. The financial importance of such a loss will be readily appreciated.

I will now proceed to explain each of the methods which have been employed for the detection and prevention of such waste.

METHODS OF RESTRICTING WASTE.

First Method of Restricting Waste.—This is the simplest, but crudest of methods, and consists merely in restricting the supply, by turning off the water at the main. Owing to its extensive adoption, there are millions of people in this country to whose houses the water comes only during 20 to 100 minutes a day. This most harmful, and, I believe, most expensive of methods for the restriction of waste, is commonly known as intermittent supply. It is carried out in practice by sending men in uniform, known as turn-cocks, to turn the water on and off in the mains. Time will not allow me to do more than state superficially the evils of this system. They have been told over and over again, but are not yet sufficiently understood.

1st. Ordinary cisterns for the storage of potable water are dangerous, on account of the great difficulty of keeping them constantly clean, while the mode in which they are commonly connected with water-closets, renders them still more dangerous. Under intermittent supply, such cisterns are necessary. Under constant supply, they are not necessary.

2nd. When, under intermittent supply, the flow is daily intercepted, the water left in the main and pipes gradually finds its way out at taps opened in the lower parts of the district, and at defects in the pipes or fittings. By this means, the main is partly emptied, and an indraught takes place at defects in the higher parts, to fill the void thus occasioned. This indraught may be air, or it may be—and frequently is—foul water. As the leaks usually most difficult of detection, and therefore most permanent, are those immediately above sewers and drains, the air thus forced into the main is frequently the air of sewers or drains. The water similarly forced in is too commonly the water of foul closet pans, the outlets of which are stopped, or partly stopped. This foul air, or water, is often infused into and served with the next day's supply. It would be difficult to exaggerate the horrible nature of the facts of this kind, which I have personally ascertained to be inseparable from the intermittent system of supply.

3rd. The whole of the twenty-four hours' supply for use, misuse, or waste, is driven through the main in a fraction of the twenty-four hours. If, for example, as is commonly the case, the duration of supply is one hour, the average rate of flow in the mains must be twenty-four times as great as with a constant supply, in which the waste has, by other means, been similarly reduced. The result is that, during that hour, the pressure in the mains is greatly diminished, and the consequence in case of fire is shown in London by the almost universal necessity for the use of fire engines. When, on the other hand, a fire takes place during the intermission of supply—that is, probably, during twenty-three hours out of the twenty-four—there is no water to be had in the service main until the arrival of the turncocks, and the pressure is then so far diminished by leakage, that fire engines are still necessary.

I have never found any one who could give a good reason for the continuation of this obnoxious method of restricting waste; but the people have borne it, and, under a false impression that it is economical, the authorities have continued it.

From the method of restricting leakage by reducing the number of hours during which that leakage can take place, I now turn to the more legitimate methods of restricting leakage by preventing leaks.

Second Method of Restricting Waste.—This method, like the last, is simple, but expensive and crude. It consists in nothing more than replacing all, or nearly all, the pipes and fittings, both public and private, with new ones of a better kind.

The first well-known case of its adoption was by the Norwich Water Company, who obtained, in 1859, the necessary Parliamentary power to apply this method in its broadest sense.*

The application of the method was instrumental in reducing the rate of supply during 24 hours from 40 to about 15 gallons per head—which comparatively low consumption was maintained by one house to house inspector to about 30,000 persons.†

This is probably a fair example of what could be done by such entire renewal, in a town with but few water-closets, and in which about two-fifths of the houses were supplied by public standpipes. Power to make the same radical change has since been obtained by several other towns.

Unless it can be shown that defects incapable of repair exist in all the fittings, and that the mains and pipes are, throughout, in such a condition that existing leaks, even if detected, could not be usefully repaired, this method is obviously wasteful alike of the money of the public and of the water authorities. But the only other means of detecting waste then known were inadequate to cope with so bad a case as Norwich then presented, and there was probably no alternative, if the change from intermittent to constant service and a reduction of the supply were to be accomplished.

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* For the Clauses referring to this matter *vide* Appendix I.

† *Vide* "Report of Dr. Pole, F.R.S., to the Board of Trade and the Home-office, in 1870 and 1871, on the Constant Service System of Water Supply."

When such work has been performed, the system of distributing mains and fittings is left precisely as it would be in new waterworks, carried out with the same skill and care. But the fittings and pipes do not remain new, they deteriorate rapidly, and if left to themselves, their condition is, in time, little better than before their renewal. The deterioriation of domestic water fittings, however good, is known by experience to most of us; the deterioration of iron and lead pipes is only observed by a few of us; it is due, chiefly, to local defects in the iron or lead, or to the kind or condition of the soil in which they lie. Obviously, therefore, absolute renewal, even under the most perfect conditions, is not of itself sufficient. Some mode of detecting deterioration, and of checking it is next required; and the mode generally adopted is that of house-to-house visitation by inspectors of the water-works' authorities, followed by notices to renew or repair served upon the owners. Such inspectors, however, fail to detect the invisible waste, and as to their efficiency in the detection of superficial waste, I shall have more to say anon.

Third Method of Restricting Waste.—This method is simply the system of house to house inspection carried out without renewal of the fittings or pipes, and it is obvious that the last method and this may be combined in various proportions. As a typical method, however, it should be taken alone. It is the method generally adopted by those authorities who have adopted any method whatever other than the first, or intermittent supply, and who are not in possession of the Parliamentary powers necessary to enable them to call upon owners or occupiers to renew or repair their fittings when not actually wasting water. As already stated, house-to-house inspection is incompetent to discover invisible waste; and for each visible leak detected, the inspector of necessity visits many private premises in which no waste is taking place.

Fourth Method of Restricting Waste.—By this method the examinations of the inspectors are confined to the particular premises in or under which waste is actually taking place, and the hidden as well as the superficial waste is detected. The advantages and peculiarities of this method will be best understood by a short account of its inception. In the year 1865, Liverpool had adopted the first method of restricting waste, viz., the intermittent system, and had combined with it the second method, or house to house inspection, on the scale of one inspector to 111,000 persons. This number was gradually increased, until in 1870 it became one inspector to 58,000 persons; in 1871, one inspector to 43,000 persons; and in 1872, one inspector to 36,000 persons. During the same time the first method of restricting waste was applied with increasing stringency, by diminishing from time to time the number of hours supply per day, until it was reduced to 9 out of 24; but, notwithstanding these precautions, the rate of supply gradually increased, and the condition became so critical, that two or three such dry seasons as sometimes occur in succession would have brought about a disastrous water famine. In this emergency the Liverpool Corporation proposed to seek for Parliamentary powers to enable them, if necessary, to adopt the second method of restricting waste, *i.e.*, the method of renewal. But the Borough Funds Act by which, if a poll is demanded, the decision of the representatives of the people is referred to a plebiscitum, had then been passed, and the people, or rather those who took the trouble to vote, for only 44,259 out of 151,853 possible votes were returned, disallowed the expenditure necessary to support the Bill in Parliament.

The first method of restricting waste, viz., restricted or intermittent supply, had for many years been applied. The second method, house-to-house inspection, and repair or renewal of detected cases, had long been in operation, with a yearly increasing staff. There was no known method left, and it, therefore, became imperatively necsssary to investigate the causes of waste more minutely, and, if possible, to devise some method by which a larger proportion of that waste could be brought to light.

An experiment on a large scale, for it extended over a population of 31,080 persons, was then made, at very considerable cost, by the Corporation of Liverpool. That experiment was directed to the determination of the exact nature of the waste in a manner which has been described elsewhere, and it was proved that the different methods of restricting waste produced the following results respectively:—*

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* *Vide* Minutes of Proceedings of the Institution of Civil Engineers, on the "Systems of Constant and Intermittent Water Supply," by George Frederick Deacon, M. Inst. C.E. Vol. xlii., Session 1874-75, Part IV.

	Gallons per head per day.
The population of 31,080 persons, as left by the third method of restricting waste, viz.—ordinary house-to-house inspection, with one inspector to each 36,000 persons required a supply of.........	33·5
On the application of the first method of restricting waste, viz., intermittent service, by which the supply was limited to 9½ hours out of the 24 the rate of supply became	19·5
By the detection of waste by bareing and examining, and, if necessary, renewing the pipes, and by employing nearly all the Liverpool inspectors in this comparatively small district, the supply, notwithstanding the abandonment of the first method, and the restoration of constant service was reduced to	13·3

The results of this costly experiment were ascertained by fourteen ordinary positive and integrating meters placed upon the mains supplying different sections of the district. Among other things, it was conclusively shown that complete renewal of either mains or fittings was an unnecessary and wasteful process, and that if only the locality of each leak could be brought to light, its prevention could be effected at a comparatively insignificant cost.

The possibility of detecting the existence of a leak, by taking advantage of the conduction of the sound, caused by that leak, through the iron or lead pipes to some metallic surface upon which the ear could be placed, had long been known, and in isolated cases, where the existence of a leak had been suspected, this method had been practised. Moderate quiet is necessary for its performance, and moderate quiet in towns can only be obtained at certain hours of the night. But to apply such a method as a system had hitherto been properly regarded as impossible, because of the necessity it involved for supervision of a kind which which has never been found practicable. It was obvious, however, that if, by any means, such a method could be systematically adopted and maintained—results unknown before in connection with the detection of leaks would accrue. If, for example, men at moderate wages, instead of going from house to house during the day, and finding merely a visible defect in, perhaps, every tenth house, could be sent out in the dead of night, with stethoscopes, and with means of access to metallic communications with the mains and pipes, sufficiently close together; and if a record of their success or failure could be made by an instrument beyond their control, the certainty of success would be as great, at least, as the certainty with which a tell-tale clock keeps a watchman awake.

Stop-cocks upon the house-service pipes provided the metallic communications accessible from the street; they also provided a ready means by which a flow through any one of the house-service pipes, to waste, could be easily shut off. This shutting off produced an instantaneous change of flow in the main, and all that was necessary, therefore, was to devise and place upon the main an instrument capable of recording by means of some such diagram as that on Fig. 1, the flow in units of volume per unit of time at each and every instant. Such a diagram cannot be produced by adding clockwork and pencil to any integrating meter, positive or inferential, except by the employment of complex mechanism, but it can be obtained by an instrument of a simpler and totally different kind.

In Appendix II. will be found a description of the waste-water meter in its most recent form; differing in some important respects from the forms hitherto described. The instrument is so connected with any water main that the whole of the supply to a population of 1,000 to 4,000 persons passes through it, and that, without any loss of pressure measurable by ordinary pressure gauges. The upper line of the long diagram on Fig. 1 is copied from the diagram drawn automatically by a waste-water-meter, in which the rate of movement of the paper past the pencil was, for experimental purposes, multiplied by four. The other diagrams on the same sheet are, however, the forms in which the paper is generally printed. It is prepared with the vertical hour lines, and with the horizontal quantity lines, and is readily fastened to the drum of the instrument. For practical work, this more compressed form is quite sufficient. Figs. 3 to 7 are examples of diagrams drawn upon such forms in different places by waste-water meters. They all of them show in gallons per hour the rate of flow at any time of the day or night. They show, by a perfectly horizontal line, at some time of the night, a perfectly uniform flow, caused by water running to waste, and they show the varying flow of water caused by use and misuse, and distinguish it from the waste by a varying line.

I will now explain the modes in which the waste-water meter system is employed in practice, and in doing so, I will take as an example the case of a town containing 100,000 persons. The number of waste-water meter districts into which such a town could be conveniently divided would depend entirely upon the arrangement of the water mains, but it would probably be fifty or sixty. Upon the main supplying each such district, a waste-water meter is placed in such a manner that the whole of the water supplying that district passes through the meter. If in such a town, any system of inspection whatever has been adopted, there are probably not less than three inspectors. If they are fairly intelligent men, they may be retained, and no more will be required.

Having fixed the meters and outside stopcocks upon the house-service pipes, if such stopcocks do not already exist, all ordinary systems of inspection are at once set aside. One inspector fixes blank diagrams at the rate of 30 a day, and brings to the office as many diagrams from meters upon which they may have been placed from one to seven days before. In a few days from the commencement of the work, the manager has before him the whole 60 diagrams, with the waste per hour visible at a glance, and with the waste in gallons per head, entered by the inspector or a clerk on the diagram, in the space left for the purpose. He finds, probably to his surprise, that out of the 60 districts the diagrams show, that in 10 the waste per head is five times as great as in 10 others, and that without any reason by which any divergence might have been anticipated. As a matter of fact, the divergence in the rate of waste per head, even in adjoining districts, of which the history is the same, and of which the external conditions are similar, is often greater than five to one.

Instead of wasting the energy of his men upon all the districts in rotation, the manager now concentrates his attention upon the most wasteful ten; and with the worst of these he probably begins his work. Two inspectors receive orders at night to visit that district, and, in order that they may confine themselves to the right blocks of houses, and omit none, they are provided—in Liverpool, at least—with a small plan of the district, showing the houses supplied through the meter in question. Having reached the district between 11 and 12 o'clock p.m., one of two methods is adopted.

By the first and most general method, the stopcocks are sounded in rotation, by using the ordinary stopcock turning-key as a stethoscope, and any stopcock through which water is heard to be running is shut off, the time and number being noted by the inspector. The shutting off and time of shutting off are simultaneously recorded by the meter on the main, to which the inspectors have no access. On the pavement, above each stopcock so closed, the inspector marks a cross in chalk. If after closing a stopcock the sound continues, it is obviously caused by waste from the main, or between the stopcock and the main. It is then generally heard at several stopcocks, and by its relative loudness at each, an approximation is made to its position. The footway and the carriage-way pavements are then sounded, until a spot of maximum noise is found. Here, again, a chalk mark is left, which rarely fails to show the position of a burst pipe or ferrule to the day inspector, who, with his labourer, visits the district on the following day. At the end of two to four hours, the round of the whole district has been made, and the inspectors find themselves again not far from the meter. They next close the main stop-valve, near the meter, and leave it closed for a minute or two. Commencing with this valve, they then reopen all the closed stopcocks, which are readily seen by the chalk marks, and return to the night office, where each inspector writes in copying ink on the left-hand side of a book the particulars of his inspection.* By the second method—rarely necessary except when waste has already been very much reduced—the whole of the stopcocks are at first shut off without sounding. On the return journey, they are opened one by one, and sounded; the result is obviously to magnify the sound resulting from small leaks, supplied by cisterns with ball-taps.

At 9 o'clock on the same morning the day inspector receives a press copy of the night inspector's reports. He visits those premises and those only, in or under which waste is reported to be actually taking place, and the work of many days' inefficient house-to-house inspection is efficiently performed in one. He generally on the same evening writes in red ink, opposite the night inspector's report, the results of his examination. He also issues the necessary notices for repairs or renewals.

On the same day, the manager or his clerk receives and records the meter diagram from the district in question. He sees by that diagram the time during which the night inspectors were continuously engaged, and he sees the exact amount of useful work performed in that time. It would not be possible, even if the inspectors had access to the meter, to elude this knowledge. He sees, moreover, the total quantity of waste detected, and one month hence he will see by another diagram the result of the day inspector's efforts to stop it.

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* See Appendix III.

It is readily seen that the secret of the success of this system, as compared with that of house-to-house inspection, is due to the facts :—

1st.—That the inspectors are always working in the most wasteful districts.

2nd.—That the time occupied in inspection is greatly shortened.

3rd.—That the hidden as well as the superficial waste is detected.

That the inspectors are always working in the most wasteful districts has already been shown at page 744. That the time occupied in inspection is greatly shortened may be shown as follows :—

Under the ordinary system of house-to-house visitation, one man, in one day, can inspect, on the average, the dwellings of about 180 persons. Under the waste-water meter system, the wages paid to him generally suffice for the thorough inspection of the premises occupied by more than 1,000 persons.

That the invisible as well as the visible waste is detected, has already been explained. This invisible waste frequently exceeds, on the average, one-half the whole waste, and where a thorough house-to-house inspection, occupying a given number of men a given time, and detecting a given quantity of waste, is followed by an inspection under the waste-water meter system, it is generally found that the same number of men suffice to detect two to three times the volume of waste in one-fifth the time. When in conjunction with this fact, we take the additional advantage to the latter system of having the inspectors always engaged in the most wasteful districts, its relatively high efficiency is sufficiently obvious.

Whatever results have been obtained by any other method can be brought about by the method I advocate, much more cheaply, both to the water authority and to the householder, and with far less trouble and annoyance to all concerned. This system has been applied within the last nine years to districts containing about 1,500,000 persons.

PREVENTION OF WASTE WHEN DETECTED.

The mode of preventing waste when detected is not affected by the manner of its detection. It will be agreed on all hands, that when it is decided to replace a fitting or pipe, that fitting or pipe should, like those to be used in new premises, be of the best possible kind, and should be fixed and adjusted in the best possible manner. A description of the fittings which have stood the test of time and experience would increase this paper to double its present length. I can, therefore, only state that the soundness and efficiency of water fittings can only be conclusively determined by taking each to pieces, examining each part in detail, and finally testing the whole under pressure. Such an inquisition finds defects in a certain proportion of the fittings made by firms even of the highest and most deserved repute. It has been adopted in Liverpool with marked success.

The fittings there used are such as encourage, rather than discourage, the proper use while preventing the waste of water. No pea ferrules or other obstructions to the flow of water are permitted ; no taps in which the duration of flow is limited are required, except for out-door stand pipes ; and water-closets are not allowed to have new cisterns providing a flush of less than two gallons.

The respectable local plumbers have been invited to sign an agreement to conform to the water regulations issued by the Corporation. The incentive to them to do so is the advertisement of their names on the backs of the waste-water notices. A plumber's name may at any time be erased if he fails to comply. In practice, it is found that work is rarely performed except by men whose names appear in the list, and that there is, therefore, no sale except for fittings tested and stamped by the proper officer of the Corporation.

CONCLUSION.

In conclusion, I desire to remark that among different systems for the detection and prevention of waste, that must be the most desirable by which the greatest volume of water flowing to waste is detected and localised at the least cost, and by which, when the waste is detected, the defective fittings or pipes are most efficiently renewed or repaired.

Regarding the system I have advocated, there has been much misapprehension, and the real object and effect of the night inspections, and of the diagrams upon which the time of the inspectors, and the results of their investigations are recorded, have not been generally understood.

The method, however, has now been applied to districts containing about 1,500,000 persons, including every class of property, and I am glad to say that it has at last been applied with remarkable success to a large population in this metropolis. As the Secretary of the Lambeth Water Works Company is present, I will say nothing further on this point.

For many years the system was objected to in America on account of the alleged practical difficulty of isolating the districts sufficiently for the purpose. The matter, however, has been taken up by Mr. Wightman, the City Engineer of Boston, U.S.A., and under the able direction of Mr. Dexter Brackett, the Assistant Engineer, it has been applied with great success to the Charlestown district of that city, the population of which is about 30,000.

The cost of adopting the method has always been insignificant in comparison with the value of the results obtained, and is generally entirely covered by the saving of water in from six to 12 months.

APPENDIX No. I.

SECOND METHOD OF RESTRICTING WASTE.

The following are the clauses of the Norwich Water Works Company's Act of 1859 relating to the control of the waste:—

22 Vict., cap. 15.

"XLV. For the purpose of preventing the waste, misuse, or undue consumption or contamination of the company's water, the company from time to time may prescribe the size, nature, strength, materials, mode of arrangement, and repair of the pipes, valves, cocks, cisterns, water-closets, and other apparatus to be used, and may interdict any arrangement, and the user of any pipes, valves, cocks, cisterns, water-closets, and other apparatus which in their judgment may tend to any such waste, misuse, undue consumption, or contamination.

"XLVI. The company shall not be bound to supply any water, unless the pipes, cocks, cisterns, water-closets, or other apparatus to be made of such size, nature, strength, and materials, and be so arranged and repaired, as the company from time to time prescribe or approve; and, in the event of any dispute as to whether such pipes, cocks, cisterns, water-closets, and other apparatus are of such size, nature, strength, and materials as aforesaid, or have been so arranged and repaired as prescribed and approved by the company, such dispute shall be settled by two Justices, either of the city of Norfolk, or the county of Norfolk, in the manner provided by 'The Railways Clauses Consolidation Act, 1845,' with respect to the recovery of damages not specially provided for, and of penalties, and for the determination of any other matter referred to Justices.

"XLVII. The company may, after twenty-four hours' notice, repair or alter any pipe, valve, cock, cistern, water-closet, or other apparatus of any person supplied by them with water, so as to prevent any waste of water; and the expenses of the repair or alteration shall be repaid to them by the person on whose credit the water is supplied thereto, and may be recovered by them as damages.

"XLVIII. Every person supplied with water by the company who wilfully or negligently suffers any pipe, valve, cock, cistern, water-closet, or other apparatus to be out of repair, or so used as that water supplied to him by the company is wasted or misused, so as to allow an undue consumption of the company's water, or to allow the return of foul air or other noisome or impure matter to return into the pipes belonging to the company, or connected with the mains or pipes of the company shall, for every such offence, forfeit to the company not exceeding five pounds."

APPENDIX II.

DESCRIPTION OF THE DIFFERENTIATING WASTE-WATER METER.

The waste-water meter is placed either directly upon the main, or, when the traffic is too great for easy access in this position, upon a loop leading to the water beneath the footway. Fig. 9 is a section of the apparatus as fixed in the ground beneath the carriage-way. In its passage through the meter, the water passes down a vertical, hollow, truncated cone, the upper end of which is the same diameter as the water main, and the lower end of which is considerably larger. Within this conical tube, there is a horizontal gun-metal disc, carried by a brass concentric stem, which is guided vertically by a brass tube, in which it slides. By its own weight, therefore, the disc tends to lie at the bottom of the chamber below the cone. From the upper end of the stem carrying the disc passes a fine vertical wire through two small bushes of phosphor bronze, out of the water-chamber and into the dry chamber above. From between the two bushes there is a drain-pipe, so arranged as to intercept any water oozing through the lower bush, and thus to prevent its passage through the upper bush into the dry chamber.

In the dry chamber the disc wire is attached to a small carriage guided vertically, and supporting a metallic pencil. The carriage is held up by a vertical wire-cord passing over a pulley, only the edge of which is shown, to a counterbalance weight at the back. This counterbalance weight is considerably heavier than the disc and its attachments, so that when no flow is taking place, it holds the disc up at the top of the conical tube. Directly a flow takes place, the disc is pressed down, and the water passes between it and the cone

The disc carriage and pencil come to rest when the downward pressure, due to the velocity of the water, is equal to the upward pull exerted by the excess of the counterweight over the weight of the carriage in air, and of the disc and its stem in water. There is obviously, therefore, for each particular velocity of water, a particular position at which the pencil will stand below the zero line; that zero line being the position assumed by the pencil when the disc is at the top of the cone. Presented to the pencil around a vertical drum, is a sheet of metallic paper, like that on Fig. 2. The zero line of this paper is at the top where the pencil stands when there is no flow. The drum is caused to revolve by a damp-proof clock within and below it, seven times in one week. Now, suppose water to be passing, the disc will descend to a given position, and the pencil will descend also, until it points to the position below the zero at which the diagram shows, let us say, 1,000 gallons per hour. The rate of flow will then be 1,000 gallons an hour within two per cent., and so on for any other position. The revolution of the drum once in 24 hours, insures that the mark made by the pencil at any recorded instant shall represent the rate of flow in gallons per hour at the same instant. Thus, in a main supplying 3,000 or 4,000 persons, the closing of a single tap is shown by a sudden rise in the line, and the quantity per hour, by the difference in the flow before and after the closing. If the opening of the tap is shown, the duration of the flow is obvious also. When, for any such purpose as a fire, a volume of water is drawn from the main, greatly in excess of the ordinary discharge, the disc falls to a point below the conical tube, and the area of water-way is then as great in every part as the area of the pipe, and the reduction of head is therefore insignificant. In this respect, the waste-water meter differs especially from all other meters, and especially from those of the inferential kind, in which the area of waterway is generally reduced to at least one-sixth of the area of the pipe upon which the meter is placed. Another point of essential difference is that, inasmuch as the resistance to motion caused by the counterbalance weight is constant, the motive power is also constant, and the meter is therefore equally correct, and equally sensitive at high and low velocities.

The functions of the meter as a differentiating meter are obviously entirely different from the functions of any integrating meter, positive or inferential, whether or not clockwork and pencil are employed.

APPENDIX III.—WASTE-WATER METER SYSTEM FOR THE DETECTION OF WASTE.

EXAMPLE OF NIGHT INSPECTOR'S AND DAY INSPECTOR'S REPORTS IN A DISTRICT OF 243 HOUSES, OUT OF WHICH WASTE WAS FOUND TO BE TAKING PLACE IN 21, IN ABOUT TWO HOURS AND FIVE MINUTES.

Name of District............Gilbert-street Date...April 4, 1882.
Number of meter ....187.

Street.	No.	Report.	Time stop-cock shut.	Night Inspector.	Premises supplied.	Day Inspector.	Date of Day Inspection.	Report of Day Inspector.
Marsh-lane	27	Noise	11.54	Griffiths	house	Jones	April 5.	B. C. store cistern. Noticed.
,, ...	102	Noise	12.2	,,	house	,,	,,	Burst lead pipe under passage. Noticed.
Lodwick-street	2	Noise	12.5	,,	warehouse	,,	,,	B. C. store cistern. Noticed.
,,	18	Noise	12.10	,,	house	,,	,,	Screw-down tap in scullery repaired.
,,	27	Noise	12.16	,,	house	,,	,,	Pipe burst under parapet. Repaired.
,,	38	Noise	12.20	,,	house	,,	,,	B. C. Double V. Regulated.
Trueman-street	5	Noise, open or shut	12.31	,,	...	,,	,,	Iron pipe burst. Repaired.
,,	19	Noise	12.48	,,	warehouse	,,	,,	Ball cogged in store cist. Noticed.
,,	22	Noise, open or shut	12.55	,,	...	,,	,,	Ferrule leaking. Renewed.
,,	28	Noise	12.58	,,	house	,,	,,	Tap in wash-basin. Noticed.
,,	37	Noise	1.6	,,	house	,,	,,	Ball-cock washer replaced.
,,	42	Noise	1.11	,,	house	,,	,,	No waste at visit.
,,	45	Noise	1.14	,,	house	,,		Pipe burst under cellar. Noticed.
,,	52	Noise	1.21	,,	house	,,	,,	Tap in bath-room. Noticed.
Clayton-lane ...	29	Noise	1.40	,,	Laurence Hotel	,,	,,	B. C. store cist. Fixed new washer.
,, ...	22	Noise	1.43	,,	12 cottages	,,	,,	2. B. S. S. Noticed. New washer.
,, ...	17	Noise	1.47	,,	house	,,	,,	Cock in wash-basin. Repaired.
,, ...	14	Noise	1.51	,,	house	,,	,,	Crack in lead pipe in cellar. Noticed
,, ...	5	Noise	1.56	,,	house	,,		Bath-room tap, W. C. supply valve. Noticed.
,, ...	6	Noise, shut or open	1.59	,,	house	,,		Service pipe burst. Noticed.

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks to Mr. Deacon, said it was impossible to over-rate the importance of this subject, and they must all be satisfied that Mr. Deacon had successfully grappled with the difficulties connected with the waste of water. He hoped they all appreciated the distinction between the misuse of water in a house, and the waste of water which did not even come to the householder to be misused. The term waste might be adopted where a person used two pails of water when one would be sufficient, but that was not the waste to which reference had been made; it was simply misuse, and, as Mr. Deacon had said, it would be better to allow any amount of misuse, than to interfere with the free employment of water. If a constant supply were given to the householder, to draw at all times of the twenty-four hours as much as he required, that must be all that he needed; but then it became of the utmost importance that the other consumption, which never reached the householder at all, but was wasted outside the house or within it, should be stopped. They knew that the waste of water in these ways was very great indeed, how great was never properly understood until Mr. Deacon took the matter in hand. The instance of Norwich, which had been referred to, was one of the earliest in which the matter was dealt with by the stringent methods described. This, however, involved the refitting of nearly all the houses; but the results were so marked, as to make it obvious that with care and attention, a large saving could be effected in the use of water. Then came the difficulty as to the expenditure involved and the trouble to the inhabitants. Mr. Deacon, by devising the system brought before them to-night, was enabled to make the water record its own history, so that when waste was going on, it could be detected, localised, and stopped. Where these waste-water meters were introduced, the town was divided into districts, and it was soon found that some of these districts were much worse than others, and instead, therefore, of the efforts of the authorities being directed, without any guide, to every district in rotation, they could at once, by knowing where the greatest waste was occurring, pay special attention to those districts. Not only so, but when they came to a particular district, the leakages within that district could be localised; they might find that 80 houses out of 100 needed no attention, and that 20 only were doing all the mischief. In this way, therefore, it became easy in a short time to stop a large proportion of the waste, leaving other districts, which were not subjected to the same amount of loss, to be dealt with more at leisure. Some years ago, when this matter was in its infancy, he was called down to Liverpool, and spent more than one night in prowling about the streets, listening at the taps, watching the waste-water meters, and seeing the instructive record drawn on the papers. The course pursued was this. They observed the meter, and saw what was taking place on the diagram before the inspection began; then they locked it up, made the inspection, found out where the sound of waste was heard, turned off the tap, and made a note of the time. When they had finished the round, they came back, took the paper off the meter, and found that at each hour and minute, when a tap was turned off, there was a diminution in the water used; thus corroborating the accuracy of the indications afforded by the stethoscope. The diagram on the wall was too distant for him to see the particular hour indicated by the ruled lines, but he could tell the hour to which each line referred, by the demand then prevailing for water. This told him that the white line down the centre represented midnight, and for some time after that there was practically no consumption of water; then between 3 and 4 o'clock there was a sudden elevation in the line, showing that some one had drawn water for a few minutes; at half-past 5, some early risers began to use water, and soon after 6 the curve rose rapidly; and again between 7 and 8, and about 9, there came the ordinary daily consumption, which went on until about 7 in the evening, when there was a gradual falling off until midnight again. He thought they must all be much struck with the extreme delicacy and sensitiveness of the instrument Even the opening and shutting of a single tap would be recorded by it. This apparatus had involved a great amount of thought and care in its invention and construction, and its success had been most marked. There were difficulties in introducing it at first, because it demanded some outlay, but anyone who looked into the matter would see that that outlay was as nothing compared to the saving which it effected. The waste of water was a most serious matter, because it was often difficult to get a proper supply, especially in dry seasons, and it could not be got and distributed without a large outlay of capital. If a town were wasting more water than it was really using, it was evident that double the number of houses could be supplied with the same amount of capital outlay. He thought, therefore, he had said enough to show the importance of the subject, and the success with which Mr. Deacon had grappled with it.

Mr. ROBERT RAWLINSON, C.E., said he had been much gratified by listening to this paper. His attention had necessarily been called to the supply, the waste, the use, and also to the abuse of water, and he had long known that the waste of water was in excess of its legitimate use. This waste was not only not beneficial economically, but it was positively mischievous in many ways. It saturated the subsoil, and it prevented many persons getting a legitimate supply when most needed. It was most mischievous by causing many towns to resort to the intermittent supply. In a place he had recently inspected as a Royal Commissioner, one-third of the inhabitants had no water except what was fetched from stand-pipes fixed in the street, at a considerable distance from the houses, and having

[Supplement to the "Journal of the Society of Arts," December 2, 1881.]

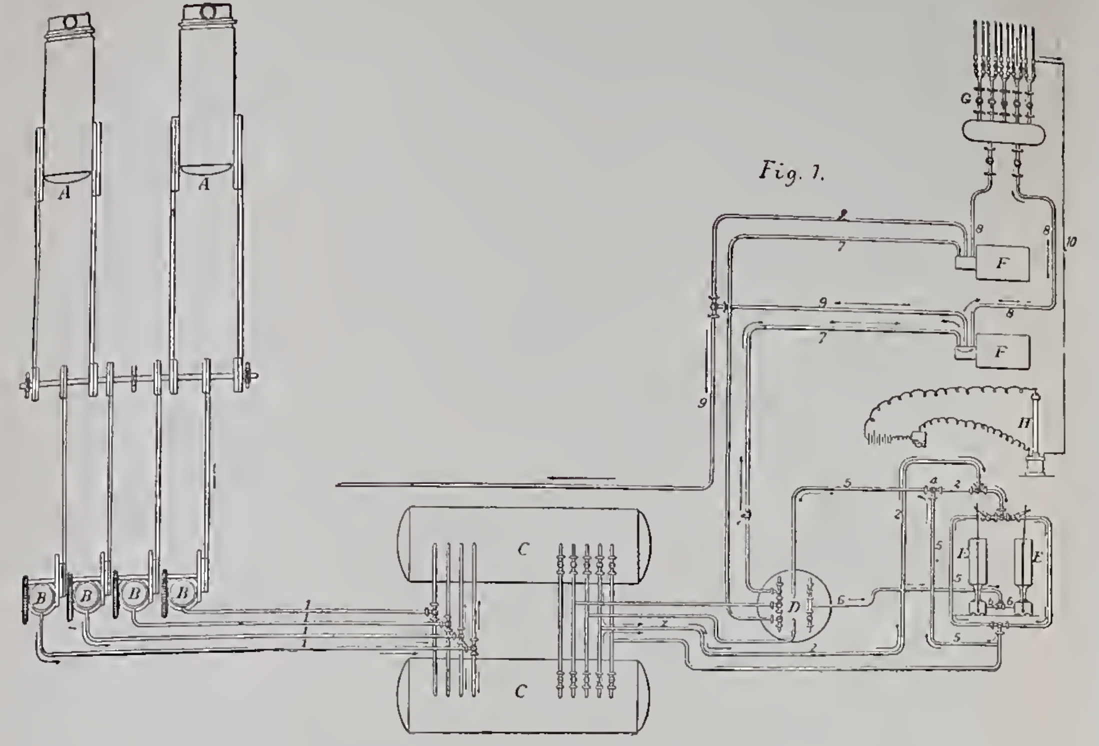


Fig. 1.

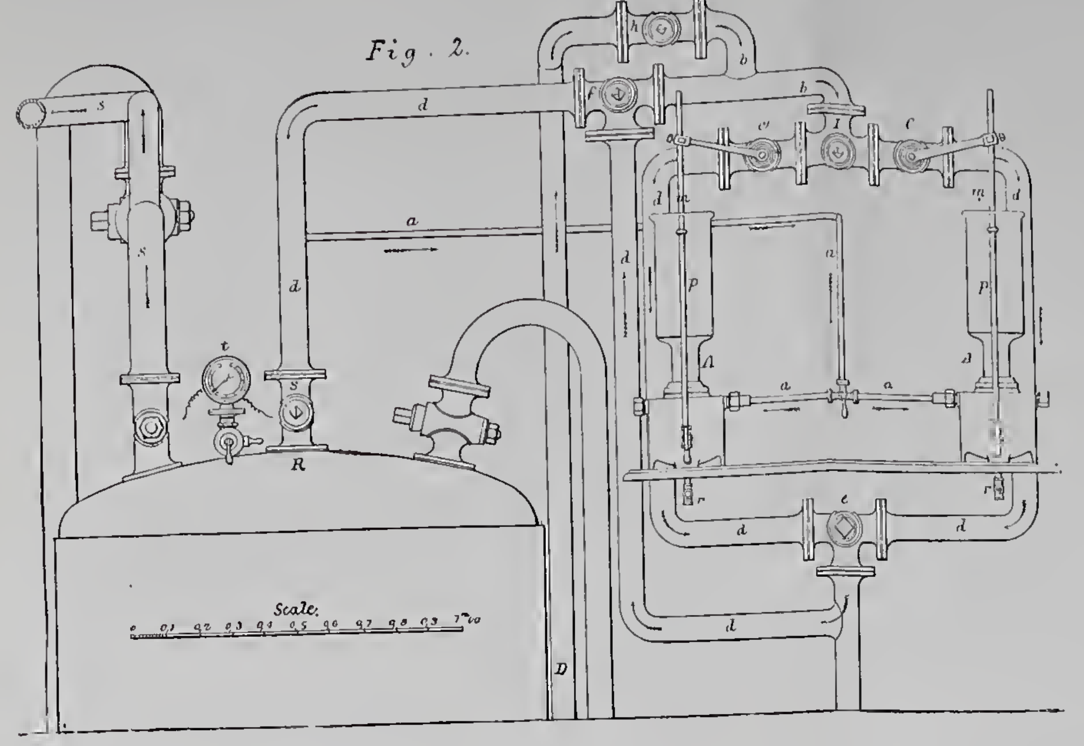
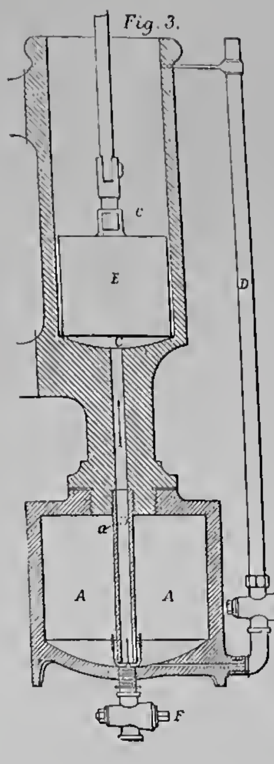


Fig. 2.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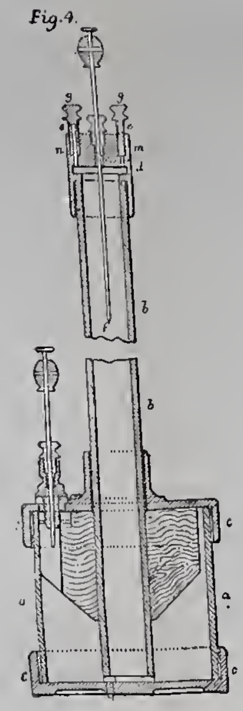
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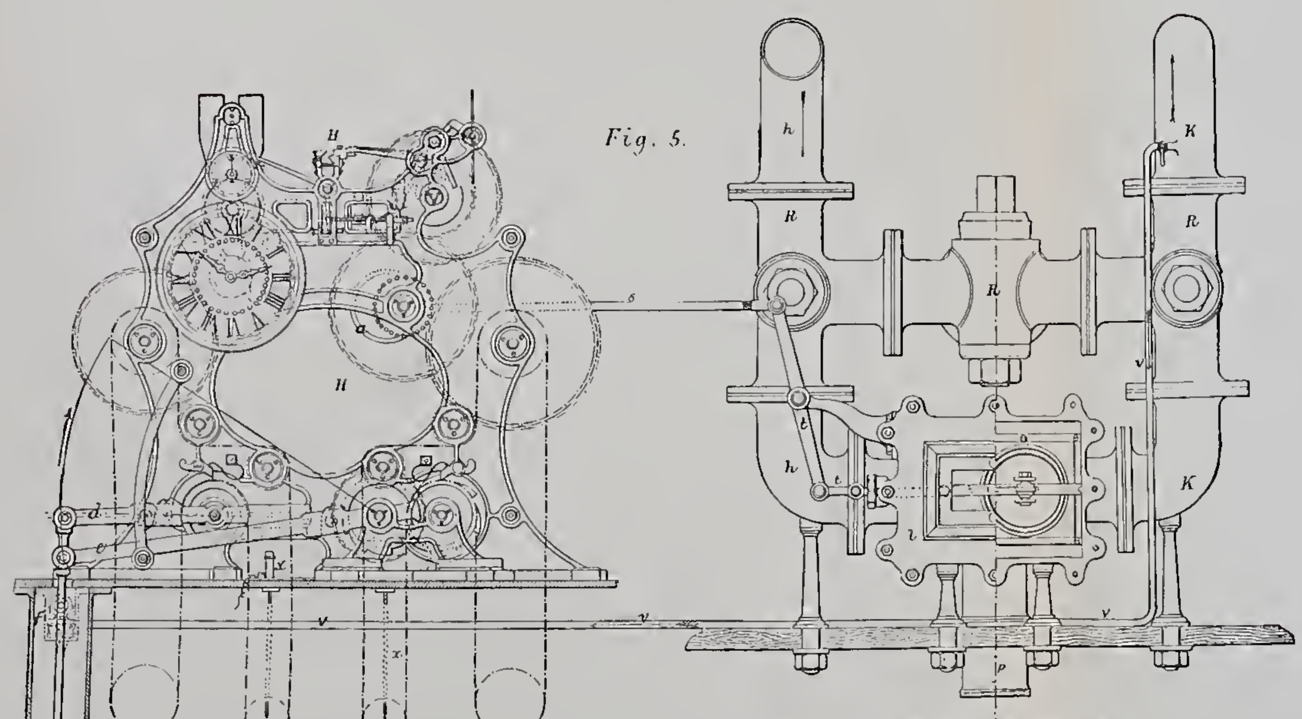
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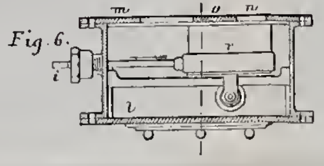
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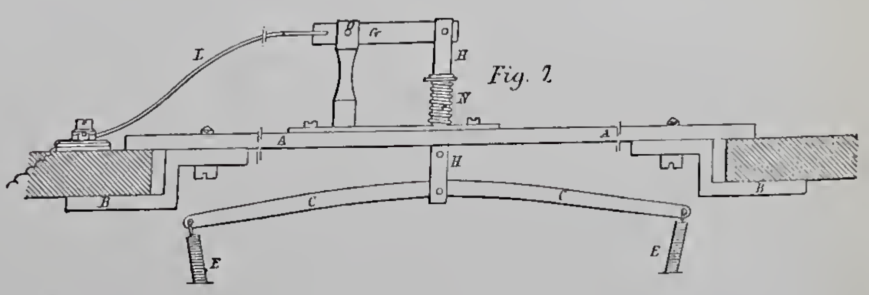


Fig. 7.

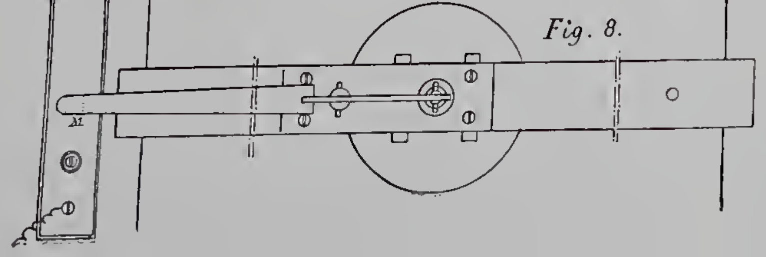


Fig. 8.

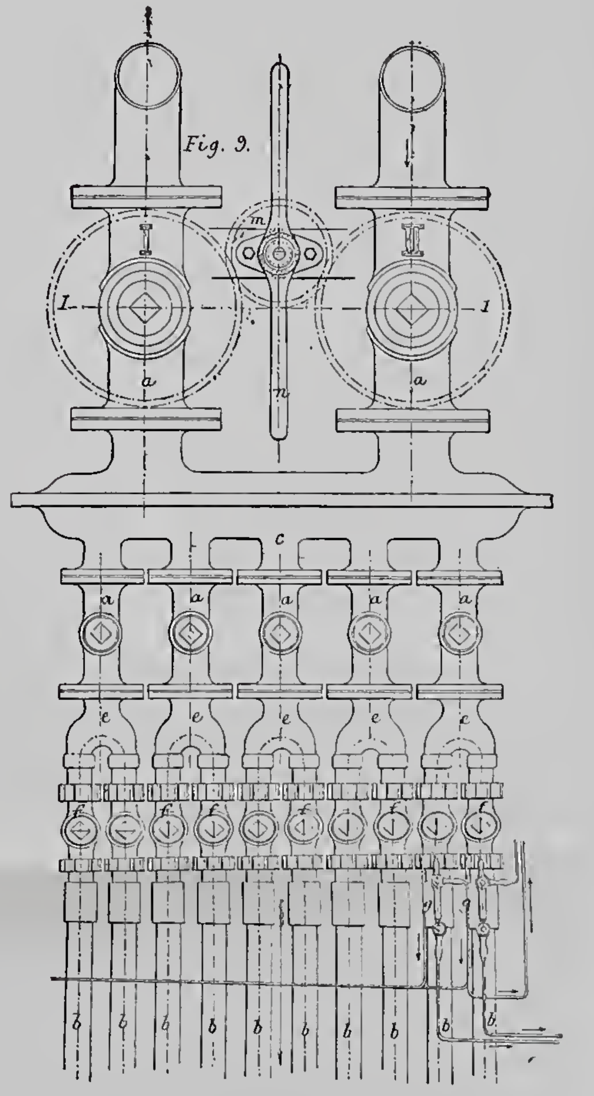


Fig. 9.

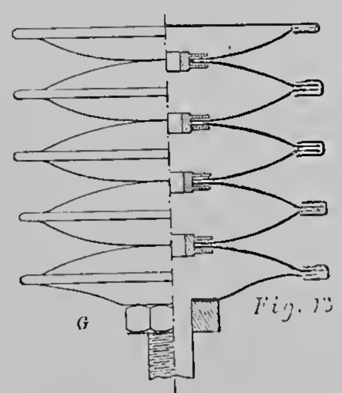


Fig. 12

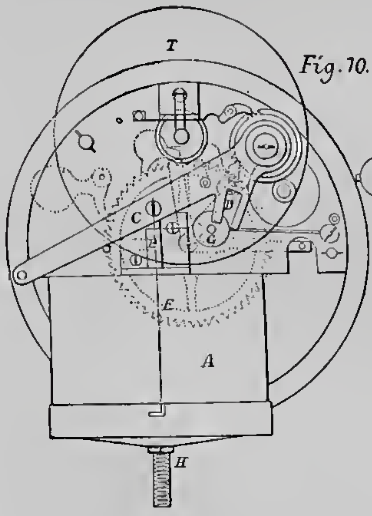
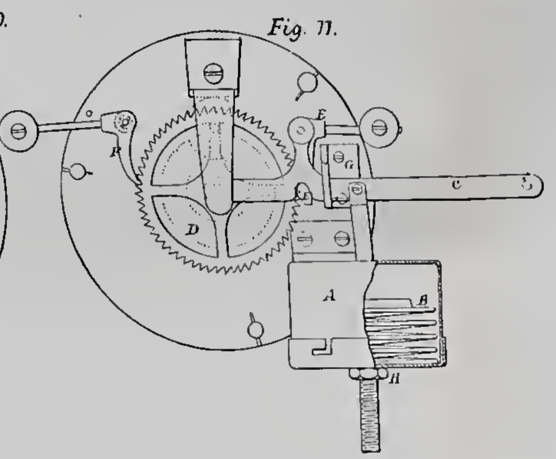


Fig. 10.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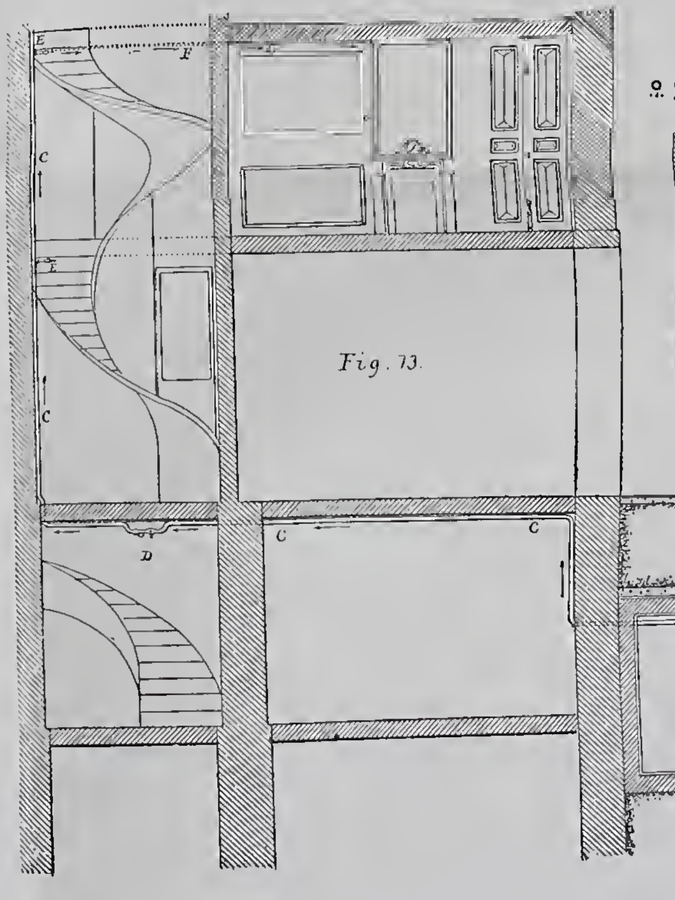
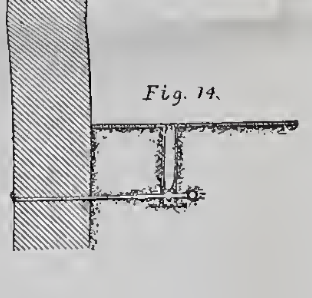


Fig. 13.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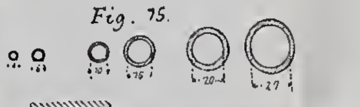
Fig. 15.

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no receptacles in which to keep it, it was used and also abused in the most abominable way. He would say that no town was properly supplied, when the water was placed and delivered externally; all water supplies, to be of the greatest possible use, should be internal, and if Mr. Deacon's system were properly carried out, it would be easy to give even a one-room tenement in a beggar's lodging-house an internal supply, which could be used and could not be comfortably wasted. Many persons thought that a high-pressure water-supply was wasteful, but where the mains were sound, and the distributing apparatus properly arranged, and the fittings had been tested in the way Mr. Deacon had described, the higher the pressure, within a moderate limit, say, up to 150, or even 250 feet, the better, because, if the supply were put inside the tenement, he would guarantee there would be no continuous waste of water, as the moment it began to waste, it made such a noise and mess, that the inhabitants were glad to send for the fitter, and have the taps put in order. The ordinary fittings were what were called screw-down taps. In some towns, where he had insisted on the supply being taken into the houses, and on what he could not get London engineers to listen to—wrought-iron service-pipes being used, he had made fitters out of common labourers, who had, after a few weeks' practice, fitted house after house with wrought iron pipes, having screw-joints, which had been working now for more than twenty years. He knew one man, a policeman in a country town, who, after he had left, obtained the appointment of local surveyor, and succeeded in keeping 1,200 sets of fittings in perfect order for twelve months, at a cost not exceeding £5. The services had all a shut-off cock, the pipes were wrought-iron, on which the taps were screwed; the taps were screw-down taps, which anyone could take to pieces in two minutes. If one of them was found to leak, it was immediately taken off by the inspectors, replaced by another, taken away, and, with a new leather, was ready to be used again. He thought Mr. Deacon really deserved a gold medal for his most valuable paper.

Mr. LOUTTIT (Secretary to the Lambeth Water Company) said the desirability of giving a constant supply to the inhabitants of London had not been lost sight of by the Water Companies. In the Lambeth Company the directors, under the advice of their engineer, had laid out very large works with that object, but when they were completed, it became necessary to see how this could be accomplished without entailing a very large waste of water. He happened to be in Liverpool four or five years ago, and having heard of Mr. Deacon's invention he called upon him, and had an opportunity of seeing how the plan worked. He made a report upon it to his directors, and it had been adopted throughout their constant-supply districts. Since October, 1878, they had provided a constant supply to 18,000 houses, and in those districts they had 25 of these water-waste meters, and should have had more, but no doubt there was such a demand for them that they could not get them fast enough. The population supplied was 59,731, and the average consumption before this system was introduced was 35·09 gallons per head per day; but afterwards it was reduced to 15·28 gallons, so that the saving per head per day was 19·41, or about 20 gallons per head per day, which in those districts represented something like one million gallons per day. The diagram showed very clearly the beneficial results. They were steadily progressing with the constant supply, and he hoped that in about 18 months the whole of their town district, about 30,000 houses, would have it. The great point which struck him in the paper was that there should be no restriction on the use of water; all they wanted to check was the illegitimate waste. This mostly arose from bad fittings and joints, and he only wished they had more "approved plumbers" in his district. The amount of waste from defective pipes and bad joints was almost incredible. Sometimes in one pipe they found 1,100 gallons going to waste per hour, which, if repeated many times, would soon reduce the head of water in the reservoir. He did not agree with all Mr. Rawlinson had said, but they might be able to derive some benefit from his experience, and he should try some of the fittings he recommended. One great advantage of this system was, that when the day inspector went round to ascertain the waste noted by the night inspector, he often found a ball-cock was stuck, and they now employed men who were able to adjust these things, so that they should act properly. Thus the inhabitants began to look on them as friends rather than enemies. Another advantage was, that being able to localise and check the waste, the pressure in the mains was considerably increased, and a better supply was given throughout the district.

Mr. BRYAN (engineer to the Blackburn Corporation Water Works) said he had adopted Mr. Deacon's system with great advantage. They were led in Blackburn, from some of their reservoirs becoming nearly dry, to adopt very stringent measures; at first they had house to house inspection, and thus cut off a large amount of waste from defective fittings; but this did not represent anything like the amount of waste which was going on from defective mains and pipes. The town was very hilly, and the working pressure in the mains averaged from 250 to 300 feet head; consequently, in many houses, although the pipes might be defective, the pressure remaining was sufficient to afford an adequate supply. In the case of mills, &c., where the boilers were supplied direct from the mains, a burst main reduced the pressure, and consequently complaint was soon made. The house-to-house visitation did not indicate in any way the leaks in the iron pipes under the streets, and the town was so intersected with old stone drains that the waste did not go into the sewers, but ran away through these old drains into the river. After supplying a few of these meters, the effect was so startling that he was authorised to supply the whole town, and he had done so to six large districts. The results of two of the first meters which were fixed were shown in the diagrams on the wall. In No. 1 district the waste was 4,500 gallons per hour, which in three months was reduced to 700 gallons, and in No. 2, a waste of nearly 5,000 gallons per hour was reduced to 650 gallons. The defects were found to be mostly drawn joints, cracked pipes, and lead over, which had burst. As a rule the fittings were good, but many of the mains had been down for 35 years, and had been badly injured by sewerage operations, which had led to settlement of the ground, and the drawing of the joints. The consumption of water for the whole town of 120,000 was formerly 29 gallons per head per day, including trade supply, but was now reduced to 20·8 gallons. At the present moment their storage reservoirs were nearly full, when, but for the introduction of this system, there would have been an absolute dearth of water. He hoped the system would soon be extended to other towns.

Sir Frederick Nicolson, Bart., C.B., as one who had something to do with the River Thames, the great source of the London supply, was much pleased to learn that there was a prospect of the waste of water which now went on being stopped, for although the supply taken from the Thames was a long way short of the quantity which might yet be taken without affecting the navigation, still the population of the metropolis was constantly increasing, and the river did not increase, in spite of what was said about floods; so that the time must come, when a part, at least, of the water supply would have to be derived from some other source. If not out of order, he should like to say a word on the state of the Thames water which was now being supplied to London. There was so much misapprehension on the matter, that he was always glad to have an opportunity of stating in public, that practically, the contamination of the Thames by sewage above the intakes of the water companies was absolutely stopped. The large towns, Oxford, Abingdon, Reading, and Windsor, had all gone to great expense, and the whole of their sewage was now stopped from entering the Thames. He was astonished the other day to see the statement in a leading newspaper that hundreds of drains still ran into the river, between Oxford and the place where the water supply was taken from; but this was a complete error. The whole of the sewage in that part of the river had been diverted, and the inspection of the river and its tributaries to the distance of ten miles was constant. Now and then small drains were found running into the tributaries, and then proceedings were immediately taken; but it might be some comfort for Londoners to know that on a recent occasion, when a local authority was prosecuted for putting sewage into a tributary of the Thames, about ten miles from the river, three of the most distinguished chemists who could be found gave evidence that any pollution put into a running stream would disappear after a course of five miles. So that he thought they might rest assured, in spite of one eminent chemist who he knew held a contrary opinion, that their water supply was not contaminated.

Mr. Henry Noel said he was a director of the New River Company, and he quite agreed with the spirit of Mr. Deacon's paper, for nothing could be more injurious to water companies than the waste of water. He recollected that when they supplied about 81,000 or 82,000 houses, the consumption of water was about 24 million gallons per day; their attention was always called specially to waste, and every effort was made to check it, and he believed with some success, for though they now supplied 137,000 houses, the average daily supply was less than 27 million gallons. One cause of the increased supply was due to the obligation which was imposed on water companies some years ago, of supplying water on Sundays; but the greatest increase of all was when the Shoreditch local authority insisted on having a constant supply. The first day that constant supply was given, the consumption rose by five million gallons. That showed that it was not even lavish consumption which affected the supply, but waste, and nothing else. There would be no difficulty in meeting the supply, if the system of checking waste indicated by Mr. Deacon came into general operation. One reason why the application of the constant supply in London was so difficult, if not impossible, was, that some years ago there was a regulation Bill passed, which provided that existing fittings should be considered to be good and sound, and seeing that was not really the case, unless extra power was given to the company to insist on the best fittings being used, there would always remain an amount of waste which was hardly to be calculated. He could see that if this system were introduced, one of the great difficulties with which companies had to deal would be got over, but he could not endorse the opinion that a constant supply was needed.

Mr. Rawlinson said the companies were not bound to give a constant supply until the fittings were in good order.

Mr. A. Dickon said the provision referred to was that existing fittings, if sound, should be considered proper fittings.

Mr. Deacon, having been called upon to reply, said the average supply in London was about 35 or 36 gallons per head per day over the whole metropolis, and it was perfectly obvious, from what had already been done, that there could be no difficulty in reducing it to 20 gallons. Whether it would be done he did not know, because it would require the same kind of energy and determination that had been displayed by the secretary and engineer of the Lambeth Water Company. With regard to the purity of the London water, he must say he was somewhat perplexed by the different opinions of chemists about it; still he took this broad fact, that London was amongst the healthiest cities in the world. He would call attention to diagram (Fig. 8), which showed the history of the Liverpool water supply, from 1860 to the present time. It told its own tale. The upper diagram showed the first period of wasteful supply, as a period of no intermisson. In the middle of 1865, intermittent supply began, and in 1875 it ended. It was followed by a period of constant supply, or no intermission, to the present time. Corresponding with this there was, as shown by the diagram, a large rate of supply during the period of wasteful constant service, up to the middle of 1865. The introduction of intermittent supply in that year produced some diminution; but with the return to constant service, and the introduction of the waste-water meter system, came a much more marked diminution, until at the end of 1875, with constant supply and the waste-water meter system, the supply was less than it had ever been before, and in two years more it had reached the present low nominal supply. The lower diagram showed the death-rate during the same years from the zymotic diseases which were generally believed to be influenced by water supply and other sanitary matters. This diagram was not placed in juxtaposition with the others because he believed that there was any important connection between them, but in order to answer the objection that is sometimes made to the prevention of waste on the assumption that it is useful in flushing drains, and preventing certain causes of disease. As a matter of fact, the zymotic death-rate is seen to be least when the waste is least, and the flushing of drains by waste is an impossibility.

The vote of thanks to Mr. Deacon was carried unanimously, and the meeting adjourned.

Miscellaneous.

NATIONAL EXHIBITION AT TURIN.

An influential general committee has been formed, with the Duke D'Aosta as President, for holding a purely national Exhibition at Turin, in the summer of 1884, as a complement to that of Milan last year. The Parco del Valentino is proposed as the site, and the buildings are to cover double the area of the Milan Exhibition. The idea is progressing beyond expectation, and the shares of the guarantee fund are reported to be taken up well. An appeal to co-operate is made to industrial, scientific, and artistic institutes, chambers of commerce, and agrarian councils. Local committees, with power to send delegates to the executive council, are to be formed throughout the country, for serving as an intermediary between the management and exhibitors; for interesting the population in the undertaking, whether as exhibitors or otherwise; for deciding on the admissibility and quantity of proposed exhibits, thus avoiding expense and disappointment; for assisting producers in preparing and forwarding their exhibits, and especially for ascertaining that the articles sent are really of Italian production. Another, and important office of the local committees, will be to obtain and impart information as to improved processes of manufacture, and as to foreign markets for produce. All natural products will be admitted, with a few obvious exceptions, a limit being put upon the quantities of stone, ores, metals, &c. The Art Commission make an appeal to Italian artists to contribute to the Fine Arts Exhibition that will be held in connection with a collection of ancient works of art. Consuls in other countries are also urged to interest foreigners in the Exhibition, and induce them to visit it. The president of the executive committee is Count Luigi Ferraris; and the vice-presidents, the Commendatori Tommasso Villa, and Ulrico Geisser.

Correspondence.

PUZZOLANA.

With regard to the use of puzzolana for harbour work, the artificial blocks that are used at Genoa are made of concrete, consisting of seven parts broken stone and four and a half parts of hydraulic mortar; one-fifth of the volume of the blocks being of stone, laid in regular courses in this concrete. The hydraulic mortar is composed of one part rich lime from Sestia Ponenta, and two parts of Roman or Bacoli puzzolana.

Amongst the other volcanic products that have the property of rendering hydraulic fat-limes, may be mentioned *trass*, which is found abundantly on the banks of the Rhine, and *Santorino* from the Greek islands of Santorino, Therasia, and Asprosini, is frequently used on the Dalmatian coast for foundations under water. This substance appears to be a mixture of a natural cement and sand, composed of fragments of pumice-stone and other volcanic substances.

P. LE NEVE FOSTER.

Obituary.

VICE-ADMIRAL NOLLOTH.—Vice-Admiral Matthew Stainton Nolloth, died on Thursday, the 11th inst., at his residence in North-terrace, Camberwell, in his 72nd year. He entered the navy in 1824, became a sub-lieutenant in 1830, and was promoted to a lieutenancy in 1838. As senior lieutenant of the *Childers*, he served in 1843 in China, distinguished himself in the operations in the Yang-tse-Kiang. Admiral Nolloth was elected a member of the Society of Arts in 1879, and he served on the Committee appointed to consider the best means for the Protection of Ships from Fire and from Loss by Sinking. He was also a member of the Royal Geographical Society.

General Notes.

FIRE RISKS OF ELECTRIC LIGHTING. — The Society of Telegraph Engineers has taken up the suggestion made by Mr. Preece, when presiding at the reading of the paper by Mr. Bolas, on the 3rd inst., upon the Fire Risks of Electric Lighting, and have appointed a committee to consider this subject. The following gentlemen form the committee :— Prof. W. G. Adams, F.R.S., Sir Charles T. Bright, T. Russell Crampton, M.Inst. C.E., R. E. Crompton, W. Crookes, F.R.S., Warren De la Rue, F.R.S., Prof. G. Carey Foster, F.R.S., E. Graves, Prof. D. G. Hughes, F.R.S., W. H. Preece, F.R.S., Alexander Siemens, C. E. Spagnoletti, A. Stroh, and Sir William Thomson, F.R.S.

MEETINGS OF THE SOCIETY.

Wednesday Evenings, at Eight o'clock :—

MAY 24.—English and Foreign Technical Education. By E. C. ROBINS, F.S.A. Professor FLEEMING JENKIN, F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evening, at Eight o'clock :—

MAY 23.—"The Gold Fields of West Africa." By Captain CAMERON, R.N., and Captain RICHARD BURTON.

Thursday Evening, at Eight o'clock :—

MAY 25. — "Recent Passages of Zulu-Kafir History." By ROBERT JAMES MANN, M.D., F.R.C.S., F.R.G.S. The paper will be illustrated by photographs, shown by means of the oxy-hydrogen light. [This date has been altered from May 23.]

INDIAN SECTION.

Friday Evening, at Eight o'clock :—

JUNE 2.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. ROYLE. [This date has been altered from May 26.]

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Fourth Course is on "Book Illustration: Old and New." By J. COMYNS CARR.

LECTURE 3, MAY 22. — Modern processes of illustration. Influence of photography. Surface printing. Intaglio printing.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. Comyns Carr, "Book Illustration: Old and New." (Lecture III.)

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. Evan Powell's Paper.

Royal Geographical, University of London, Burlington-gardens, W., 2 p.m. Annual Meeting.

Asiatic, 22, Albemarle-street, W., 4 p.m. Annual Meeting.

TUESDAY, MAY 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Captain Cameron and Captain Richard Burton, "The Gold Fields of West Africa."

Royal Institution, Albemarle-street, W., 8 p.m. Professor A. Gamgee, "Digestion." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. W. Proctor Baker's Paper, "The Various Systems of Grinding Wheat, and on the Machines used in Corn Mills." 2. Mr. Henry Simon, "High Grinding by Roller-Mills in England." 3. Mr. William Bishop Harding, "Roller-Mills and Milling as Practised in Budapest."

Anthropological Inst., 4, Grosvenor-gardens, S.W., 8½ p.m. The Right Hon. Sir H. Bartle Frere, "Systems of Land-Tenure in Different Countries."

WEDNESDAY, MAY 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. C. Robins, "English and Foreign Technical Education."

Geological, Burlington-house, W., 8 p.m. 1. Mr. George Attwood, "The Geology of Costa Rica," with an Appendix by Mr. W. H. Huddleston. 2. Mr. S. V. Wood, "The Newer Pliocene Period in England." (Continuation of Part I.) 3. Prof. H. G. Seeley, "A Remarkable Dinosaurian Coracoid from the Wealden of Brook, in the Isle of Wight, preserved in the Woodwardian Museum of the University of Cambridge, probably referable to *Ornithopsis*." 4. Mr. G. R. Vine, "Notes on the *Annelida tubicola* of the Wenlock Shales."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Linnean, Burlington-house, W., 3 p.m. (Anniversary Meeting, for election of Council and Officers, and President's address.

THURSDAY, MAY 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Dr. Robert James Mann, "Recent Passages of Zulu-Kafir History."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "Historical Outlines Traced in Early Artistic Symbolism."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Metals." (Lecture VI.)

Inventors' Institute, 4, St. Martin's-place, W.C., 4 p.m. Annual Meeting.

Society of Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Lieutenant A. H. Bagnold, R.E., "The Organisation and Operation of the Field Telegraph Corps in the Transvaal, 1881; also some general remarks on Field Telegraphs."

FRIDAY, MAY 26...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir Henry S. Maine, "Sacred Laws of the Hindus."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning Society, University College, W.C., 8 p.m. Papers by Mr. Hume C. Pinsent and Mr. W. Sharp.

SATURDAY, MAY 27...Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor D. Masson, "Poetry and its Literary Forms."

Journal of the Society of Arts.

No. 1,540. Vol. XXX.

FRIDAY, MAY 26, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and concluding lecture of the fourth course of Cantor Lectures was delivered on Monday evening, the 22nd inst., by Mr. Comyns Carr, on "Book Illustration, Old and New." The lecture was specially devoted to the consideration of modern processes of illustration, and of the influence of photography, of surface and intaglio printing.

A vote of thanks to Mr. Carr, for his interesting course of lectures, was carried, on the proposition of the Chairman (Mr. B. Francis Cobb).

The Lectures will be printed in the *Journal* during the autumn recess.

CAPTAIN BURTON'S PAPER.

The paper by Captain Richard Burton, on "The Gold Fields of West Africa," the reading of which was postponed on Tuesday last, owing to the sudden illness of the author, will be read at the last ordinary meeting of the Society, to be held on Wednesday, 31st May.

FOREIGN AND COLONIAL SECTION.

At the meeting of the Section, held on Tuesday, May 23rd, Lord Alfred S. Churchill, Member of Council, in the chair, a paper was read by Captain Cameron, R.N., on "The Gold Fields of West Africa."

In consequence of Captain Burton's illness, his paper on the same subject was not read.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Exhibition was opened on Wednesday, 24th inst., and will remain open every day from 10 to 4 (Saturday 10 to 2) until Friday, 30th June. Members of the Society will be admitted on signing their names, and can admit friends either by use of the tickets supplied for the evening meetings and lectures, or of their visiting cards.

A catalogue of the Exhibition will be found at p. 769 of this number.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 14th June. The cards of invitation will be issued next week.

Proceedings of the Society.

TWENTY-THIRD ORDINARY MEETING.

Wednesday, May 24th, 1882; Professor Fleeming Jenkin, F.R.S., in the chair.

The following Candidates were proposed for election as Members of the Society:—

Arkinstall, Charles, Highfield, West Bromwich, Staffordshire.
Graham, William Coryton, 18, Prince of Wales-terrace, W.
Gregory, John Waterson, Bedminster High School, Bristol.
Hill, John, Ennis, Co. Clare, Ireland.
Hulse, William Wilson, The Grove, Withington, near Manchester.
Mitre i Vedia, Emilio, Buenos Ayres.
Silvester, John, Sandilands, Towyn, Merionethshire.
Tudor, Edward Charles Buchanan, Goole, Yorkshire.

The following candidates were balloted for and duly elected members of the Society:—

Barker, Thomas, Beecwoods, Aigburth, Liverpool; Llandudno, and Devonshire Club, St. James's, S.W.
Beor, E. J., Southern Bank, Aylestone-hill, Hereford.
Best, Alfred, "Freemasons' Tavern," Great Queen-street, W.C.

Collens, William James, 2, Gresham-buildings, Guildhall, E.C.
MacNamara, John Moore, 46, Great College-street, Brighton.
Shillito, H. S., Hatfield-park, Herts.
Terry, James, 4, Freemasons'-hall, Great Queen-street, W.C.

The paper read was—

ENGLISH AND FOREIGN TECHNICAL EDUCATION.

By Edward Cookworthy Robins, F.S.A.

One of the special objects for which this Society was established, in 1754, and for which this Hall was erected twenty years after, is distinctly that which the title of the present paper suggests, viz., the extension of knowledge in respect of all those natural sciences which underlie the various industries of this and other countries. This circumstance (coupled with the fact that compulsory examinations have now become necessary to membership in many scientific societies) leads me to think it desirable to take note of the prospects of technical education, and the comparative value of English and foreign methods.

The very title itself is a "bone of contention," and on the present occasion I do not contemplate an exhaustive discussion of the whole subject in all its bearings, concerning which Sir William Thomson has said, "I do not know what a technical class is exactly." But I shall attempt an introduction to its study, by a classification of the objects to be obtained, of the classes of society intended to be benefited by it, and of the means proposed for adoption to that end.

It is impossible to listen to the various opinions from time to time expressed by speakers and writers on the subject, without being struck with the confusion of ideas which results from indefinite generalisations, made from a variety of standpoints, and usually empirically enforced as the only panacea for all the evils—real and fancied—which afflict the body politic of our industrial communities.

One enthusiast connects technical education with the development of manual dexterity, another with mental activity and scientific training, a third with a combination of both in one and the same person. One thinks the study of the application of scientific principles to industrial pursuits should precede apprenticeship, another that it should follow it, and a third that it should go on concurrently with it. One thinks our apprenticeship system the best, another the worst, and a third denies its present existence, and sighs for its resuscitation, or the substitution of something else in its place, neither English nor foreign, but emphatically suited to the needs of the age we live in, and the racial peculiarities we represent. One thinks technical education should commence in our primary schools, another in our secondary schools, and a third, that every school should have its technical side as sharply developed as its classical proclivities were, are now, and ever shall be. One thinks it is our artisans who are at fault, another their masters, a third the altered conditions of both; but all agree that the maintenance of our acknowledged superiority in technical matters cannot long be continued while we ignore the deficiencies which may exist in our present practice, and complacently shut our eyes to the advantages which other nations are affording to their populations.

The energetic, independent, self-helpful qualities of the national character remain, its individuality as strongly marked as its insular position and prejudices, but as time rolls on, the conditions of life and labour are changed, and it follows that the ancient educational customs of the people, the old-world order of things, must needs change too, to meet the pressing wants of a superabundant population, and a revolution of thought and feeling, place, and circumstances, the result of fifty years of scientific development and commercial prosperity.

Within that period of time, bounded by my own life's experience, what have we not seen achieved? In fifty years to come what may we not expect? The steam-engine employed for manufacturing purposes, and for locomotion by land and sea, and all the developments of mechanical engineering sketched forth so ably by the Chairman of this Society's Council, Sir Frederick Bramwell, in a paper read before the British Association at York, last year, are already outstripped by the transmission of power by means of gas and the electric current, one system following upon another so quickly, that the breath is shortened and the brain bewildered by the quick succession of mechanical applications of physical laws, known to some extent in the abstract, but undeveloped before.

In this brief period of time, gas has succeeded oil lamps, and the electric light is extinguishing gas, as the sun eclipses all lesser luminaries. Railroads have supplanted stage coaches and inland canal navigation, steam vessels have well nigh superseded sailing craft, as iron has wood, and steel iron, in their construction; and armour-plating the "wooden walls of Old England."

Chemistry, physics, mechanics, biology, geology, mineralogy, crystallography, metallurgy, telegraphy, &c., are comparatively new sciences, the growth and applications of which have originated new centres of labour and thought, and constructed a new people out of an old stock, with new surroundings, new tastes, new wants, new purposes, hopes, and aspirations.

The intellectual and social condition of the industrial population, and the character of the education it should receive to fit the national mind to cope with the national progress, cannot be met by an extension of scholastic institutions, based on the requirements of the middle ages.

Yet this is the spirit which has dominated our universities, and, until very lately, no concessions have been made to the reasonable demands of progressive civilisation.

Secondary education has followed suit, and the study of the intricacies of dead languages has been thought more profitable than the study of God's laws hidden away in the universe, and revealed only in answer to scientific research.

Primary education was left to the various religious denominations to wrangle over, till within the last decade; and the hopes of all men, untrammelled by vested interests, or party feelings, have come to centre round the roots of the national education tree, and not with its decaying branches.

The School Board is the starting-point of modern British educational legislation, and the improvement of the technical education of the masses which has begun, and is destined to widen, will necessitate a like improvement in all the grades above them. Intellectual superiority is the true mastery, and a knowledge of things, in preference to that of words, will be the distinguishing characteristic of the twentieth century. Who does not know (excepting, perhaps, one class, that of mechanical engineers) that amongst skilled artisans, the master and apprentices of old time have been absorbed in the general contractor and his followers—the result of the inevitable competition accompanying the spontaneous growth of all nations? A sharp distinction is everywhere made between capital and labour, to the prejudice of the social status of the latter, because money can dispense with native work, and enlist the more intelligent foreign workman. This world-wide introduction of machinery has minimised handicrafts, and magnified mechanical production, with the unexpected but consequent result of raising the value of purely artistic developments everywhere.

If we are losing by competition in scientific applications with foreign countries, we are absolutely gaining in artistic development, for which alone we have made provision. The influence of South Kensington upon the artistic productions of the country has been great and beneficial, and the turn that fashion has taken in architecture has favoured the process; for whereas heretofore the exterior embellishment of a building was the chief aim of the designer; now, the attainment of interior comfort, beauty of detail, and harmony of colour, is the leading idea. Fecundity of artistic power in design is genius rather than talent—an instinct, rather than an acquirement — except so far as its means of expression are concerned. Well cultured speech best clothes fittest thought.

Art cannot walk freely in swaddling clothes, and thus it is that the freedom of choice and the individuality of the English artist is beginning to tell abroad, and the originality of English taste in architectural and ornamental design is rapidly supplanting continental. It is to England the Germans come for Christmas cards, original ornamental pottery, patterns for embroidery, &c.; and in Vienna lately, I could scarcely buy a *souvenir* that was not adorned with cuttings from Kate Greenaway's charming crudities. The new Industrial Art Museum and Schools in Vienna are professedly based on the example of South Kensington.

Comfortable as is this assurance in one department of art, it almost ceases there, if the following statistics may be depended on. The exports of English and Irish produce given in the statistical abstract of the Board of Trade, as quoted by Mr. Paul, of Dewsbury, at the Social Science Congress at Liverpool, in 1876, shows that, whereas, in 1872, the total exports of all kinds of British and Irish produce was £256,250,000; in 1875, three years later, it was £223,500,000 only, being a decrease of £32,750,000 sterling. And if we omit the colonies, the total exports to foreign countries in 1872 amounted to £195,750,000; while in 1875 it was only £152,500,000, being a decrease of £43,250,000. Contrasting these figures with our imports—the total imported in 1872 amounted to £354,750,000, while, in 1875, the amount had risen to £374,000,000, an increase of £20,000,000. In 1861, we only imported £217,500,000, and this shows a subsequent increase in our imports, in 1875, of £156,500,000.

Now, I am not an expert in political economy, but, on the face of it, it seems clear that, while we export much less, we import much more, and that foreign countries must profit most on the exchange. But how it is to be explained I cannot tell, unless it can be shown that we are obliged to take goods instead of money in payment of what we export, to the equivalent extent of the difference. Failing this, the only thing that would occur to a private person in such a dilemma would be to search and see under what disadvantages he might be trying to work against his more prosperous neighbour. And this is exactly what public men are doing, and this feeling has given rise to the appointment of the Royal Commission on Technical Education, the preamble of their instructions commencing thus:—

> "We have deemed it expedient that a Commission should forthwith issue, to inquire into the instruction of the industrial classes of foreign countries in technical and other subjects, for the purpose of comparison with that of the corresponding classes in this country; and into the influence of such instruction on manufacturing and other industries at home and abroad."

The Royal Commissioners have done wisely, as I think, in publishing their report in sections, and clearly defining the classes with whom they are about to deal.

1st. The instruction of the proprietors and superior managers engaged in industrial pursuits.

2nd. That of the foremen engaged therein.

3rd. That of the workmen.

Their first report has been issued, and deals with primary education only, and almost exclusively the elementary education of France, and the extent to which technical education is comprised therein. That of Germany is to follow. Let us take the same course, and consider:—

1st. The technical education of the working classes.

2nd. That of their superiors and overlookers.

It is extremely gratifying to find that the conclusion to which the Royal Commissioners have come, with respect to the relative value of the technical teaching given in France and England, is so favourable to us. They state that:—

> "It will be manifest from the description we have given of the ordinary elementary and apprenticeship schools in France, that, with the exception of the very recent introduction of manual work into the schools of Paris, and of the instruction in trades, provided in a few cases, for a small number out of hundreds of thousands of apprentices, French workmen generally, as distinguished from those employed as foremen, or aspiring to that position, have not till now, except as to systematic teaching in drawing, possessed, during the school age, better instructions than persons in a similar condition in this country."

From this it would appear that, in their judgment, it is not in the technical education of the ordinary working classes that we shall find the differences we are seeking to discover; which is the conclusion arrived at by the Conference of the Society of Arts in 1868 (hereafter given in detail).

On referring to the reports from her Majesty's diplomatic and consular agents abroad respecting the condition of the industrial classes in foreign countries, dated 1870, and made in answer to the circular of the late Lord Clarendon, primary education (which is gratuitously given in Paris, and in the provinces too, if the parents are poor) is said to comprise (in addition to the "three R's") the physical sciences, history, geography, mathematics, and surveying, and even drawing, foreign languages, book-keeping, and geometry, by the laws of 1850, which also provided for the establishment of evening schools for adults over 18 years of age, and apprentices over 12. From this it would appear that the elementary technical education of the masses in France had, at all events, a good start of us.

But the report of the French Commissioners on Technical Education in 1865, reveals a state of things much akin to our own, so far as these ordinary workmen are concerned; and in the great industrial centres, and especially at Paris, there was remarked by them "a growing tendency towards abandoning the system of apprenticeship, substituting the employment of lads as drudges, and as they began to learn by force of example, the masters raised their wages, which was their only encouragement to improve themselves."

Nevertheless, the Schools of Arts and Trades existed at Chalons, Angers, and Aix, and the *Conservatoire des Arts et Métiers* in Paris, where workmen so fortunate as to be admitted might raise themselves to the position of skilled artisans and foremen in factories and workshops, without expense, if they had sufficient energy to do so; no such corresponding advantage existing in this country. In the *Conservatoire*, at Paris, the courses were confined to lectures on science applied to industry, expressed in terms easily understood by the less instructed, but the pupils had access to a magnificent library and museum of models and machinery of art-workmanship. In the Schools of Arts and Trades the lads worked out the usual period of apprenticeship in special factories, in which a few hours of the day were devoted to the completion of their primary education. Of the twelve hours of instruction, five were devoted to theoretical instruction, such as geometry and mathematics, and seven hours to practical work in the workshop, where smiths, founders, turners, and wheelwrights, &c., were taught their trades, great attention being paid to instruction in drawing, as the art by which so many questions of mechanical science are solved.

The result of this system was not altogether satisfactory, however. The students expected to be foremen, not workmen, and were disappointed at finding that their fellow-workmen, without theoretical education, over whom they expected to rule, earned higher wages on account of their superior skill in manual labour.

In Switzerland, where education is more general, such expectations would not arise. Exceptional privileges are the proper complement of exceptional training. Since 1870, manual work has been largely introduced into the primary schools of Paris, showing that, on the whole, they find the advantages greater than the disadvantages. And in the school of the Rue Tournefort, rudimentary trade teaching is combined with ordinary elementary instruction, and workshops are being attached to some forty or fifty of the primary schools.

French apprenticeship schools for workmen have also been established, both as boarding and day schools. The municipal apprenticeship school of the Boulevard de la Villette, in Paris, is a day school for workers in wood and iron, and was established ten years ago. Similar institutions exist in the provinces, notably at Havre. The Royal Commissioners report that:—

> "The authorities of the city of Paris have deemed the experiment of the apprenticeship teaching in the school of La Villette sufficiently successful, to induce them to erect a number of similar schools in other parts of the city;"

And a sum of £80,000 has been voted for the purpose; the Prefect of the Seine reporting:—

> "That in consequence of the virtual abolition of apprenticeship in most trades, and owing to the specialisation and subdivision of manufactures, resulting from the introduction of machinery, the number of skilful and intelligent workmen in all branches of industry and art manufacture has decreased, and that the standard of technical knowledge has been lowered."

That this is precisely the case in England, cannot be universally admitted. We have improved, and are improving, though not nearly so fast as we ought; and although the Royal Commissioners do not recommend the costly experiment of building similar schools in England, they still feel that, to give value to the manual dexterity which is best acquired in the ordinary workshop, instruction in the use of tools, during the elementary school age, would greatly facilitate the learning of a trade, and shorten the time of probation, and they would be glad to see this kind of manual instruction introduced into some of our elementary schools. The labours of Mr. Thomas Twining, of Twickenham, in this direction, cannot be too highly praised. From my professional point of view, the provision of good common workmen in all the trades connected with building, is a matter of vital importance. The worry of our lives, as architects, and the shortening of them too, is the anxiety attendant on the difficulty of getting reasonably good work done, except by picked men at high wages, attached to the leading firms.

Now, let us look at Germany; what is she doing for the working classes? Very much the same as Switzerland, who preceded her and Austria in experimental technical education, but who is surpassing all the world in the provision made for higher technical education. I say, what is Germany doing for the masses of its working men?

Professor Weinhold, of Chemnitz, writes to me, in answer to this question, as follows:—

> "Generally, the working classes get no technical education beyond what they learn in the workshops during their apprenticeship days. A few of them visit a foreman's school, or any of the *Fachschulen* which exist for the different branches of industry, and some, after having gained enough money by their handicraft to live, devote one or two years to the school."

Professor Lunge, of Zurich, writes me:—

> "There are schools, both in Germany and Switzerland, intended for giving a proper technical and half scientific, but always practical, education, to workmen, so as to fit them for foremen's places. These schools have proved very successful indeed, quite as much as the Polytechnic schools in their higher aims, which latter do not touch the working classes in the ordinary sense."

Dr. Witt, of Mulhouse, writes me thus:—

"Primary schools in Germany take pupils from their 6th to 14th year. The education is compulsory. There are three classes, one of which every child must attend.

"*(a.) Volksschule* (the People's School).—Here the children learn, in addition to the three R's, history, geography, natural history, and singing.

"Children who attend this school, generally finish their education with it. They then became factory boys or farm boys or apprentices to artizans, until their 20th or 21st year, when they have to become soldiers for three years. If, after the service, they are still good for something, they return to their previous occupation, viz., they become workmen, labourers, or artisans' assistants, until they get a chance to become artisans themselves.

(b.) Höhere Burgerschule (the Citizen's School).—The same subjects are here taught, but more carefully. This is the school selected by the parents of children who are intended to have some more training, but no university education.

(c.) Vorschulen des Gymnasium.—Schools preparatory for college education, and attached to colleges; same subjects taught, together with some Latin. These are for boys who are intended to go to the university.

The above are the primary schools, besides which there are other voluntary schools, with a marked object, as the *Fortbildungs Schulen,* intended to instruct boys leaving the primary school *(Volksschule)* at the age of 14, and to train him for becoming an artisan; and the *Technikums,* which are schools entirely independent of all others, and generally supported by private means, or self-supporting. Their chief object is to educate practical engineers, foremen for workshops, dye-houses, &c. It is obvious that the scientific side of the compulsory primary education on the Continent is but little or no more advanced than our own, and the great majority of working men go straight to the workshop therefrom, while a few take advantage of *Technikums* or *Fortbildungs Schulen,* preparatory thereto. But all suffer from the disadvantage of passing the desultory life of a soldier for three years, before they can earnestly set about their business.

Professor Perry thinks that the teaching formulated by the Irish Commissioners for Model Schools in Ireland, is probably better than any other scheme of primary instruction.

The preparation necessary for passing the examinations of the Science and Art Department, or of the Technological Examinations of the Society of Arts, now taken over and so remarkably extended by the City Guilds, would alone seem to counterbalance the so-called advantages of foreign systems of technical education for the working classes, to say nothing of the broken continuity of education, and prejudicial effect of three years' soldiering.

Professor Sylvanus P. Thompson, of Bristol, is, nevertheless, an ardent admirer of the foreign system, and would import it here; and Mr. H. Solly has also written a pamphlet on the same side, and many others are strong advocates of it.

It was, therefore, a wise step on the part of the City and Guilds of London Institute for the Advancement of Technical Education—the chairman of whose executive is no less a person than Sir Frederick Bramwell, F.R.S., and whose members are picked men from the contributing companies they represent—to call in the aid of such men as Sir William Armstrong, Mr. Bartley, Colonel Donnelly, Captain Galton, Professor Huxley, and Mr. Trueman Wood, to advise with them at the starting of their great undertaking—whose essays are bound up with the first report of the Executive Committee to the General Committee of certain of the Livery Companies of London. All these gentlemen were unanimously of opinion—

1. That the teaching of the practical part of the particular trade or manufacture should not be carried out in certain establishments auxiliary to those devoted to theoretical instruction, and concurrently given in connection therewith.

2. That the practical part should be left to be acquired in workshops and manufactories, by means of apprenticeship or otherwise, supplemented only elsewhere.

3. That the function of the teacher should be confined to instruction in the various arts and sciences connected with industrial undertakings, and especially in their practical application.

It would seem that these views have been concurred in by the Presidents of the Royal Society, the Chemical Society, the Institution of Civil Engineers, as well as by the Chairman of the Society of Arts (at present also the Chairman of the Guilds Executive Committee), since associated with the City and Guilds Institute, and acting as members of their Executive Committee. At all events, the result has been that they (the Guilds) have resolved—

1. To establish (and are now building) at South Kensington, at a cost of £100,000, a central institution, or High School of Applied Science and Art for advanced students and teachers, to include courses of free popular lectures, as at the *Conservatoire des Arts et Métiers*, Paris.

2. To establish (and they are now rapidly completing) Science and Art Trade Schools in the north and south of London, at a cost of £30,000 and

upwards; morning and evening classes and lectures, and laboratory work for boys, apprentices, and workmen generally, and of all ages.

3. Grants in aid of local schools and classes suited to the industries of each locality.

4. Exhibitions in elementary schools to be held in trade schools.

5. Exhibitions in trade schools to be held at the central college.

6. Extended systems of examination in technology, based on that of the Society of Arts.

7. The affiliation or absorption of kindred societies, as the Art Carving School, the Horological and the Artisans' Institute, the City Art Schools, and others.

But we have yet to decide between the many opinions respecting primary technical teaching. Professor Huxley says:—

"I do not think that much good is to be done by attempting to deal with the trades directly, in the scientific education of the masses of the people. The great object appears to me to be, to construct such a scheme as should enable you to sift out and get hold of the men who have really scientific ability, give them a fair scientific training, and you may trust to the arts getting all they want out of them."

Professor Fleeming Jenkin (our Chairman this evening) says:—

"If you mean by technical education, attempting to teach a man his business by a college course, I think it a very mischievous delusion indeed; but if you mean that in addition to his practical training, you would give him some theoretical training, some technical courses, I think that would be very useful indeed."

Professor Ayrton says:—

"By a 'technical school,' I understand not one in which the manipulation or routine of a trade is taught, but a school where a lad receives general instruction in the principles of applied science, and special instruction in the application of these principles to the particular trade he is following, or which he is about to follow."

I apprehend that no better definition than this last has yet been given of what the term "Technical Education" should really mean, and which is as applicable to primary as secondary schools. What, then, is Professor Ayrton's method? Let me explain it to you in the language of Professor John Perry, given at the close of a very original paper, read at the Society of Arts in January, 1880, on "The Teaching of Technical Physics." He says:—

"I have studied carefully the method of teaching which Professor Ayrton is employing for the City and Guilds of London Institute, in his lectures on 'Applied Physics,' at Cowper-street, Finsbury, and I think that this method promises more success than any other which I have heard of. His method is succinctly stated at the end of his syllabus.

"'The aim of these lectures on Technical Physics will be to train the students by an examination of the machines, instruments, &c., employed in the Arts (or of models of them), to turn their attention to the scientific principles governing the action of these machines, and without a knowledge of which neither their proper working can be ensured nor improvements in them effected. It is believed that the analytical method of experimental instruction, in applied physics, will, for the class of students expected (boys, apprentices, and working men of all ages), be preferable to the ordinary method adopted in the teaching of natural philosophy, which consists in much time being spent in the study of the elementary principles, and then only subsequently the practical applications explained."

"It is to be understood [says Professor Perry], that he is taking up, more particularly, in these lectures, the principles of watch and clock making, and he reasons from that part of the subject which his students know, namely, from the appearances, and uses, and construction of the various timekeepers shown to them, backwards (or forwards), to those mechanical and physical principles with which most men begin to study a technical subject. In doing this, he makes use of all the knowledge and habits of thought which he supposes workmen to have, illustrating his lectures by means of experiments."

And gentlemen, I perfectly agree with him, and what is more, the results have already proved its value. Professor Ayrton has created for the City Guilds a system of technical education in physics suited to the masses, who have flocked in greater numbers to be taught than was at any time foreseen (between 500 and 600 students have been enrolled), and this in spite of the temporary character of the accommodation available, while a new Technical College, or Model Trade School, is being erected for the accommodation of the professors of physics, chemistry, and mechanics. Professor Armstrong has his own methods of teaching technical chemistry; and the recent appointment of Professor Perry to the chair of mechanics insures an original treatment of that subject, a foretaste of which he has given in his recent Cantor lectures before this Society.

At the same time, under the careful direction of Mr. Magnus, the technological examinations which were taken over from the Society of Arts have become so popular that, in spite of the standard of efficiency being raised, fifteen times the number of students have since presented themselves for examination from all parts of the country, in every industry, and thus a sound and sensible system of technical education has been inaugurated by the City

Guilds, the value of which cannot be overrated. It only needs an extension of the provincial trade schools, and that the School Boards throughout the country should give greater development to Froebel's system of object lessons, and follow it up with elementary classes on mechanical and natural science, taught by the analytical methods employed by Professor Ayrton, to give us a system of natural education for the masses, equal, if not superior, to that which has been initiated abroad.

I have now arrived at the second general division of my subject, viz., the technical education of the middle classes. If we have found nothing to alarm us in this contrast between the primary technical education of English and foreign nations, owing to its very recent and spasmodic application, and the limited area of its effective usefulness anywhere, the case is entirely altered when we come to deal with the secondary or higher class teaching.

It is here, if anywhere, that we have met our match abroad. It is here, and nowhere else, that we must look for the resurrection of our old precedence. But Englishmen don't mind being told of their shortcomings, they rather like it than not, it rouses the lion, and makes him rampant; it excites their competitive spirit and pugnacious instincts; it sets their brains on fire, a fire which, when thoroughly enkindled, never goes out until success is again achieved. The persistency of the national character is its salvation—given a leader in whom its faith can be rested, and it is irresistible.

The time at my disposal is too limited to review the secondary educational provisions made in all foreign countries, nor is it needful. They have culminated in the system adopted in Germany and the nations bordering upon it, which has been followed in Sweden and Russia and elsewhere. A paper was read before the Foreign and Colonial Section of the Society of Arts, in February last, on Scientific and Technical Education in Russia, by Professor J. J. Hodgetts, of the Imperial College of Practical Science, Moscow—in which he said—

> "In 1851, we, in England, were a-head of all civilised Europe—why are we so lamentably behind now? From my own experience abroad, the reply would seem to be, that other nations have had a scientific education, while we have had none. Other nations have effected a certain amount of organisation, while we seem to stand historically pledged to avoid all systems, and to dread the very idea of organisation."

This is one of the first impressions made on an Englishman abroad. The absence of paternal government at home, and the freedom from governmental restriction of any sort in his insular home, so long as he pays his taxes, unfits him to submit to the regulations which are maintained everywhere abroad, and I, for one, do not desire to import them. Our individuality would be gone, our personal energy sapped. No! let us have unity of purpose, instead of uniformity of action. Let us agree that we are lacking in something, and let us all agree to overcome the deficiency, and it will be done—done by ourselves—each in his own sphere and particular domain of industrial work. The scheme should be suited to local requirements, and supported by the commercial magnates of each centre of special industry, our teachers being made independent of results, but allowed to reap the benefit of them. Government payment in the shape of grants in aid should be given in no niggardly spirit, but be in due proportion to the local interest manifested. It should depend not only on the sums voted by personal munificence or municipal local authorities, but on the response made to it in the shape of primary and secondary students flocking to the schools.

Secondary education in Germany (which is not compulsory) is for pupils from their 10th to their 17th or 19th year. Dr. Witt thus summarises it:—

> (*a*). The *Gymnasium*, or college, in which is taught plenty of Latin and a good deal of Greek, German, and a little French; English and Hebrew taught to those who wish to learn, which most don't; a moderate knowledge of mathematics, and a little natural history, geography, singing, gymnastics, drawing, plenty of religion."

Pupils leaving any of the three highest classes (that is from the 17th year) are entitled, as a matter of course, to the "one year's instead of three years' voluntary service." For this service they may choose their own time as well as place to join the army.

From the gymnasium, pupils pass on to the universities.

> (*b.*) *Realschule* of the 1st Grade, from 10th to 19th year. Here, German, French, and English are taught; a little Latin, and plenty of mathematics; a fair knowledge of natural history, chemistry, physics, &c.; history, geography, singing, gymnastics, drawing, machine-drawing, religion. In short, a manly, self-developing curriculum.

These schools differ very much; thus, in some of them they have no Latin, but practical carpentry and engineering instead. In some they have a fair training in practical chemistry and laboratory work, in others not.

These are the schools from which the *Polytechnikums* and similar institutions draw their supply of students. The Mulhouse Chemical Institute students generally come from them. Numbers of students only go as far as the seventeenth year, and then enter merchants' offices as clerks; others leave still earlier, and become articled pupils, for a term of two to three years, in factories or engineers' workshops.

Like the gymnasium, this school gives to the pupils who successfully leave one of the three higher classes (from the 17th year), the right to claim the one year's service. Young men who have not obtained that right, by passing through one of these schools, may do so by passing a somewhat difficult examination. No greater incentive to personal educational improvement could be given than the knowledge that two years' military service is avoided by passing a successful examination.

(c.) Realschule. 2nd grade, from 10th to 17th year; same curriculum as the 1st grade, but without the two highest classes. Some of them are entitled to confer upon the pupils leaving the highest class, the right of the one year's service; others do not possess that privilege.

In some mercantile centres, such as Hamburg and Bremen, there exists a rigorous system of training the young merchants, from which nobody is excepted—not even the son of the richest banker; it is this:—The boy must finish at one of the above-named secondary schools. He then becomes for three years an articled pupil in a merchant's office. There he has, during the first year, the duties of an office-boy; during the two following years, those of a junior clerk. When the three years are over, he gets a substantial present, according to the zeal he has shown. Now he goes to join the army for one year's service, and when returning, he may either enter his father's business, or compete for a clerkship.

Besides the schools above mentioned, there are others, with a certain marked object. The *Fortbildung Schulen*, and the *Technikums*, have already been described, under the head of primary education, since they are open to students who have had no better preparation for it, and could be entered by any workmen who desired to improve his technical knowledge and social position; a valuable provision for the energetic workman, but taken advantage of by much fewer than would be expected.

Then there the *Cadetten Schulen*, which train boys entirely with a view to their becoming officers; the *Pagen corps*, for young noblemen exclusively, and intended to fit them for courtiers; and lastly, there are the two great schools in which all others culminate, namely, the *Polytechnikums* and the universities. Of the latter, I need say little, except that, as the home of literary and classical learning, the pure sciences are carried much further, and are more completely studied than with us; separate buildings, magnificently fitted with all the most recent appliances, being provided for chemical, physical, and physiological laboratories at Berlin, where men of European reputation, like Helmholtz, Hofmann, and others, conduct their overflowing classes.

But it is the *Polytechnikum*, which is, or rather, perhaps, has been, the stronghold of the scientific and technical education in Germany, Austria, and Switzerland. It is here that things take the place of words, and the true principles of nature and art, the result of scientific research, are applied to industrial pursuits. I say has been, because there are unmistakable signs that the high class teaching at the Polytechnics abroad will be the cause of their gradual supercession by the universities, where the best scientific knowledge may now be obtained, though hitherto minus its special application to specific trades. And this is not surprising, because university degrees will always take precedence of those of the Polytechnics, which, however, cost no less labour and concentrated study to secure. The provision of new buildings, which has been so generally made at the chief universities, has naturally followed the demand for increased scientific instruction, and the feeling is spreading in Germany that, owing to the growing importance of the *Real Schulen*, the universities will eventually absorb the Polytechnics, and that in future the university curriculum will be found to embrace all that formerly was the peculiar province of the Polytechnics, in addition to the abstract studies which formerly distinguished them. Our own universities and great public schools may do well to consider this new phase of educational development. It must, however, never be forgotten that the whole general education of Germans of every grade has long been in advance of the general education of Englishmen, comprehending a wider area, and a more thorough acquaintance with every branch included. This is a factor which must always be taken into account when contrasting the relative value of English and foreign technical education.

With reference to the extent to which manual labour is introduced into middle-class schools, Dr. Witt tells me that there certainly are workshops connected with some, if not all, Polytechnic schools, and also with most of the *Real Schulen*; but that, of course, they are small and insignificant, as they are merely intended to give the student an idea of the work to which his theoretical knowledge shall be applied:—

> "That apprenticeships for skilled artisans exist the same as in England, though the amount of previous education required varies very much, and is generally very small;" and he adds, "My opinion is that theoretical instruction should always precede the practical one; if possible, they should co-exist for a while in such a manner that theory gradually yields its place to practice. In all examples I have seen of the reverse, I found the young man who considered himself practically finished, despise all subsequent instruction. I also believe that previous theoretical training facilitates his practical education by teaching to think logically in all he does."

I may now refer to my own experiences in Germany.

The Executive Committee of the City Guilds recently instructed Professors Armstrong and Ayrton to make a tour of inspection of the polytechnic schools of the German-speaking countries, with the view of determining the most suitable fittings and apparatus for the new buildings in progress at Finsbury and South Kensington. As a member of that committee, I volunteered to accompany them, and I met Professor Armstrong at the beginning of January last at Strasburg, where a new university is being constructed, to cost, when finished, not far short of a quarter of a million of money. Besides the main block of the building devoted to classical learning, mathematics, &c., separate blocks of buildings, specially constructed under the supervision of the professors themselves, are being constructed for chemistry, physics, botany, &c. In short, it is to be a university and Polytechnic in one and the same institution, for high class students. The architect of this princely foundation is the professor of architecture at Carlsruhe. Thither we went to find a new technical chemistry laboratory, and school of agriculture and forestry, in addition to the former buildings of the *Polytechnikum*, with museums of specimens and models of every kind. Thence to Mulhouse, a manufacturing centre, visiting the model dwellings, the dye-works and calico printing establishments, and the chemical schools, established by the manufacturers. Thence to Geneva, where Professor Ayrton met us, and we, together, inspected the new university, chemical and physical schools. Thence to Zurich, at which celebrated *Polytechnikum* every science is taught, both pure and applied; here are separate museums of models for teaching physics, chemistry, machine engineering, architecture, drawing, modelling, agriculture, forestry, botany, &c. Here are nine professors of mathematics, 46 full professors, 54 teachers—100 in all; 490 students, and 250 auditors—750 in all, which, however, is 500 less in number than used to attend when this school (now 30 years old) had fewer competitors of its own kind, and felt less of the growing absorption of high-class students by the universities. Thence to Munich, to see the splendid new *Polytechnikum* there, the new university, chemical and physical laboratories, and Pettenkofer's Hygienic Institute, concerning which Dr. Renk writes to me to say, that it also is part of the university of Munich, its Director, Dr. Pettenkofer, being the professor of hygiene at the university. It was erected three years ago, and was a part of the Physiological Institute. It is designed for the education of students in medicine and hygiene, and for practical investigations therein. Officers of health have to obtain its diploma. Thence to Vienna, where has long been a vast *Polytechnikum* for 1,500 students, with a remarkable collection of models and objects for each department. Here are also new technological buildings, a new weaving and chemical school, just opened, &c., &c.; everywhere the provision for first-class secondary education of a technical character is extending. It has been found to give forth results which point to this general extension.

At this point, Professor Armstrong went on to Gratz, to see the new physical and chemical laboratories there, and to Buda-Pesth, whilst I and Professor Ayrton went to Dresden and Chemnitz, Professor Ayrton returning to his London classes, after visiting Würzburg, while I rejoined Professor Armstrong at Dresden, and visited the new *Polytechnikum* there. Thence to Leipsic, in which university Professor Armstrong himself studied two-and-a-half years. Here is a street full of separate new buildings, for chemical, physical, and other laboratories. Thence we proceeded to Berlin, where, besides the new university buildings for science, referred to before, is a large stone building, erected at the instance of local manufacturers, for special chemical analyses. There are fine laboratories attached, and students admitted, but certain of the work done is considered private to the members, and it is in fact a school of research.

Mr. Felkin has published a book on the "Trade and High Schools of Chemnitz in Saxony," to which I must refer you, where every kind of technical instruction is given, in both primary and secondary schools.

Aachen was the last place we visited together, here is one of the finest and most elaborately fitted Polytechnics of the many buildings we saw; it is, in itself, a lesson in technical education, of a kind that we have no examples of in this country, not only in fitting, but in heating, ventilation, lighting, and electrical apparatus associated therewith. I spent the month of January in making this rapid survey, and noting the fittings, the chief purpose of our visit; and an impression of preparedness, on the part of the countries we visited, to fight out the question of scientific superiority in technical matters, was left on my mind, that I should like to communicate to others.

My belief is that the omission of high-class scientific education for the middle and upper classes, in England, is the true cause of our being apparently outrun in the industrial race of the period; and the movement which is now set on foot has come from the right quarter, viz., from the commercial and manufacturing centres, who begin to find its monetary value.

In these schools everything is taught that can be gained at the universities, except the dead languages, while modern languages and the applications of modern science to art and industry are added, and the thoroughness with which they are taught is best evidenced by the fact that nearly all our own leading men have found it desirable to spend some years in Germany, and they frankly acknowledge we have nothing to equal it in England. All secondary education in Germany is more general and thorough.

Professor Lunge, at Zurich, in answer to my queries, first, as to the difference made in teaching pure and technical chemistry in the three years' course, and secondly, as to effect of the system upon the originality and individuality of the men turned out, writes as follows :—

"My colleague, Victor Meyer, teaches the elements of chemical science, and, further, its development in a purely scientific direction, treating the whole domain irrespective of any practical application, and merely as a science; that is, stating the facts as such, and as they occur to the chemist working in the laboratory. When his work is done, mine begins. I treat only those chapters which refer to practical applications of chemistry, naturally at a greater length, and entering into a number of details on manufacturing plant, &c., which would be entirely out of place in a course of pure chemistry." [Professor Lunge was partner in one of the largest sulphuric acid and alkali works in England before he went to Zurich.] "In fact," says he, "I enter upon the various chemical industries, as such, placing the technical side foremost, but laying the principal stress upon explaining the scientific principles underlying them. I do not believe in dictating a number of recipes for dyeing, &c.; I believe that some schools in England go too far in that respect. We have always tried to keep the mean between the entirely theoretical university training, and the entirely practical course of dyeing, brewery schools, &c.

"Thus some of our students are university professors themselves now, whilst the great majority are in practical life, and very many, heads of large technical establishments (in Switzerland, well nigh all of the younger generation) have come from us. On the whole, our *Polytechnikum* (which to a great extent is the prototype of all German ones) has fulfilled its object, and sees no reason to change its principles."

In answer to my second question, Professor Lunge says :—

"During the first year, we certainly do not aim at 'individuality.' During the last year, whilst still upholding, in a general way, the course of studies for all students, we allow students to deviate from this, so as to meet their individual likes and wants, and in the laboratories we treat each of them according to his own standing, progress, and capacity. All this refers to the ordinary students who follow the regular courses. As to the auditors, we allow them from the first to specialise their studies, and treat them quite individually; but we do not like that course, except with older men coming from practice, as many men do."

Except to the extent to which mechanical work and testing materials is done in the engineering school at King's College, and at the University College, London, we found no workshops attached to any of the *Polytechnikums* which we visited. Models of every kind of mechanical action, of every kind of machine, &c., &c., there were, but these were not made by the students; in fact, manual labour is excluded from the *Polytechnikums* generally, and is only to be found in the intermediate trade schools already described, and in them to a much less extent than is commonly supposed. Now, it is true that we have no such organisation in this country, but we are daily approximating to it. The influence of South Kensington is making itself felt, and our secondary schools are introducing science little by little, while great efforts have been already made in some of the chief towns in England.

For example, this has been done at Owens College and the Grammar School, Manchester, at Mason's College, Birmingham, the Yorkshire College, at Leeds; at Sheffield, Nottingham, Liverpool, Bristol, and elsewhere.

At the latter place the famous trade and mining school, so long established there, is about to be transferred to new quarters, at a cost of £30,000, and will be a monument of the munificence of the Society of Merchant Venturers. As their architect, I am enabled to state that no reasonable expense will be spared to render this a model school of the kind. Then, again, realisation of the complete scheme of the City Guilds will soon place London on a par with the other capital cities of Europe. The Central Institution will be an English *Polytechnikum* of the first order; the Finsbury College, a *Technikum* superior to its continental prototypes. In conclusion, what have we to learn from all this? In the first place, to support all efforts to improve the intelligence of the working classes; and secondly, to raise the standard of professional excellence.

In a paper read by Mr. Slater at the Architectural Association, the importance of the study of the natural sciences and their application to specific industries connected with the art of building, was forcibly insisted upon. Young men are too often pitchforked into the professions of engineer, architect, and surveyor, without any more relative preparedness than is the working man.

Better preparation for articles of apprenticeship is the thing most wanted in the constructive professions. Apprenticeship is the best business school, but it might be improved on its educational side. The architectural and mechanical classes at the German *Polytechnikums*, which extend over three years, and the work done in which I carefully examined, is of a better class than is usually understood; from the very first, the student has to work out the strains of every floor, or roof, or speciality in construction, and to delineate the same in skeleton diagrams attached to every plan he draws. The mechanical draughtsman is not given a subject to copy, but only the parts of a machine which he has himself to piece together, to realise the machine to be drawn, so that, from the rough sketches of the master, he has to thoughtfully work out in practical draughtsmanship the theory he has been taught to apply constructively.

True, he is surrounded with models and drawings of every mode of construction, and style of design, principles of motive power, its emission, transmission, and arrest; but they are ministering spirits, not arbitrary laws, fettering his freedom. At least, they need not be other than helps to his imagination.

We enter our articles too early; eighteen is surely early enough, but sixteen is the common time.

The establishment of examinations at our institutes will certainly help to bring about a change in this matter, and soon it is to be hoped that, just as candidates for entry to the technical educational advantages to be hereafter obtained at the Central Institution of the City Guilds will be required to produce certificates of having passed preliminary examinations at other schools of lower grade, so admission to the examinations of our professional institutes should be ultimately given only to such students as shall be able to produce similar educational certificates of competency up to a certain point, which can only be fixed from time to time, as the means of obtaining such certificates shall have been increased.

By this means, these professions will be aiding in the movement in which none can be more directly interested than they, and will prove their loyalty to our country in the best possible way, namely, that of raising the scientific tone of professional education, and fitting the students to compare with foreign competitors in the race for national predominance in every good thing, but especially that of technical knowledge, theoretical as well as practical. As a final suggestion to aspirants to professional success, let me quote the Report of the Committee appointed by the Conference of the Society of Arts, held on the 24th January, 1868, which states that:—

> "Believing that our defects are far more due to the ignorance of those who direct works, than to imperfect technical education, want of skill, or incapacity in those who execute them, the following resolutions are formulated to express our views:—
>
> "1. For the purpose of discussion, technical education should be deemed to exclude the manual instruction in arts and manufactures which is given in the workshop.
>
> "2. That the term 'Technical Education' is understood by the Sub-Committee to mean general instruction in those sciences, the principles of which are applicable to various employments of life.
>
> "3. That technical instruction, as defined above, should not, as a rule, be given in separate professional institutions, but in institutions established for general education.

"4. That, with a view to the development of a system of scientific education, it is desirable that schools be established, having for their main object the teaching of science as a mental discipline. These science schools should prepare some youths for the higher courses of a college, and other less ambitious pupils for their professional pupilage.

"5. That the subject of secondary instruction, having been reported upon ably and deliberately by the Schools Inquiry Commission, the Committee do not feel it necessary to enter into the details of this subject, while they desire emphatically to express their opinion of the necessity for the introduction of scientific teaching in all secondary schools.

"6. That it is desirable that the higher scientific instruction should be tested by public examinations, and that the proficiency of persons who pass these examinations should be certified by diploma.

"7. That the preparation for the businesses considered by the Committee is not sufficient until due scientific instruction has been followed by practical pupilage in efficient work.

"The Committee recommend employers of labour, and those in the habit of taking pupils, apprentices, and clerks, to give preference, as far as possible, to those adducing evidence of the possession of adequate instruction in the sciences applicable respectively to their professions or occupations.

One word more, and I have done. The highly educated young men from the foreign *Polytechnikums* become masters when they can, but are not ashamed, till then, to act as foremen of manufactories, &c. Now, there is a great reform required in the system by which foremen and clerks of works are appointed here. The position of a clerk of works is a most difficult and responsible one, and should stand higher in the social scale than it does, and be paid better. This will not be the case so long as uneducated mechanics form the staple from which such men are drawn. I look forward to the time when a superior order of men will become the responsible agents both of the architects and contractors. And this will follow both from the growth of intelligence in the class below them, and the educational supremacy of those above them, a result which the general spread of technical education, as I have endeavoured to define it, must inevitably produce, as "men run to and fro, and knowledge is increased."

DISCUSSION.

Professor PERRY said he had not so much sympathy with the technical education of the middle classes of England, as he had with the technical education of workmen. When the middle classes were so foolish as to send their sons into offices, and pay large premiums where they could get no technical instruction in their profession, they deserved little sympathy; he rather sympathised with the working men, who could not help themselves, but who had been so long crying out, as well they might, for technical education in the popular schools, and who had not yet acquired it. He still stood by the views he had expressed with regard to the technical education of workmen, but he found that, in practice, they were exceedingly difficult to carry out. You stood up before an audience of working men, and for the first two nights, perhaps, you followed the progammme you had drawn out, which was to talk to the workmen in their own language about a machine or an instrument; not beginning with the elementary principles of science which they had not learned at school, but taking up the machine as a whole, as they themselves understood it, and reasoning down from those general principles which they understood, to what they might have got as elementary instruction; but you found, in a short time, you gradually got into the way of thinking of these workmen as frightfully stupid, because they did not understand a little algebra and the sixth book of Euclid. The problem of teaching workmen was a very difficult one, which had not yet been sufficiently studied. It was the easiest thing in the world to draw up a programme for teaching middle-class science classes; so much so, that you found the same programme in use all over the world, from San Francisco to Japan, but a suitable scheme for working men he had never yet seen fully carried out. He hoped Mr. Robins would, at some future time, devote his attention to this subject.

Mr. MAGNUS said it would be very difficult to follow Mr. Robins through the paper, and consider, in the detail they deserved, the many points he had brought forward. It would have been interesting to him to do so, as he had recently visited nearly all the places which had been referred to; but he should have an opportunity later on of stating where he agreed with Mr. Robins and wherein he differed from him. The whole question bristled with difficulties; and no one could have listened to the paper without seeing that the views of one set of professors differed very materially from those of another set. One main lesson to be drawn, therefore, was that they should be careful not to dogmatise on what was the best system of education, technical or otherwise, for any class of persons. It might be thought he ought not to say this, as he had a voice in the councils of a body which was preparing a scheme of technical instruction, the existence of whose schools could not but be regarded as a dogmatic expression of the opinion of those who directed them. At the same time, he and those with whom he worked felt the difficulties of their position, and he was quite sure that the views at present being carried out would be modified, if necessary, on gaining further experience. As Professor Perry had pointed out, the problem of giving technical instruction to masters or superintendents, was by no means so difficult as that of giving instruction to the hands who were to work in the factory; but he might express a hope that even that problem would become much easier than it was at present, for the simple reason that, after a time, they would not require to instruct working men, inasmuch as they would have already instructed in their youth those who were to become working men. But even when the problem was reduced to that of instructing apprentices, it was not without difficulty, and the most conflicting view existed upon it in different parts of the Continent. France was moving in one direction and Germany in another. In the City of London they had endeavoured to find a solution, if only a temporary one, in the direction which he thought was the correct one, of giving evening instruction to apprentices. This system harmonised with the habits and customs of Englishmen; and a system which might be adapted to the sunny climate of Italy might possibly not be adapted to our more cloudy skies. The temptations to walk about and amuse oneself in the evening, were much greater in a beautiful climate; and here we could avail ourselves of the general desire of young men to be under some sort of cover during the evening, to impart to them that instruction which would be useful to them in their daily occupations. There seemed to be a general consensus of opinion that manipulative skill could only be acquired in the workshops, and that what was needed was to supplement that practical skill by theoretical instruction given in the evening, or at some appropriate time. It was the custom in many parts of Germany to give this instruction on Sundays, as well as on the evenings of other days; but that would probably be distasteful to the people of this country. With regard to higher education, there was a great conflict of opinion abroad as to the respective advantages of an university or *Polytechnikum* training for giving the requisite knowledge to those who were to become the managers of industrial works. But prior to this question, was another one, viz., what was the best training for a young man intended to take the lead in a manufactory, before entering the university or *Polytechnikum*. Here, again, their German advisers were by no means at one; they had established the *Real-Schule*, and on the other hand, the gymnasium; in the first, science, mathematics, and modern languages were taught; in the second, the old grammar school curriculum was followed. Then it seemed to the German educationalists that something between the two was wanted, and so they established a *Real-Gymnasium*, where part of the classics was done away with, and a little mathematics and drawing was added. Even this did not quite satisfy them, and now they were considering whether they should not establish something between the *Real-Gymnasium* and the gymnasium itself. Into these complexities he would not enter, but there lay at the bottom of all this a very important question, whether, after all, the old classical training was, or was not, the best preparation for those who were afterwards to be educated in the higher branches of science, and although the opinion was opposed to his own, he must say that there was a large number of scientific professors in Germany who were inclined to think that the old classical training was the best. What naturally occurred to one, on hearing a view of this kind, was that possibly science was not so taught in the German schools as to yield that amount of mental discipline which could be obtained by a study of the classical languages. The classical languages had been made the instrument of education for centuries, whilst the teaching of science was comparatively new, and it was quite possible that the majority of teachers, both in Germany and England, were not sufficiently skilled in pedagogic principles to enable them to fetch out of scientific instruction that mental gymnastic, and discipline which, after all, was the object and end of all secondary education. On the whole, he did not think the course which was being followed in England was very far wrong. Whilst some of the best minds were busily employed in considering what were the best methods of instruction for different classes of persons, those for whom the instruction is intended did not always seem sufficiently alive to its importance. If part of the energy of those who were elaborating schemes of education were directed to showing the importance of instruction, and not only the importance, but the difficulty of discovering any royal road to knowledge, they would be doing a very great thing. In this country people were too anxious to arrive rapidly at results to take a third year's course before the first; in Germany, this was not the case, and the students were more willing to go through a regular organised course of study. In England, education left off at too early an age, both for the workmen and the masters; and in discussing any scheme of instruction, the period over which it was to last was a most important element to be taken into account in arranging the curriculum itself. It was most necessary to impress upon all who desired to take advantage of any system of education, that time was an essential element, and that they must devote to the training for any profession a longer time than had hitherto been the custom. There were many problems in technical education yet remaining unsolved; one was the degree, if at all, to which manual work should be introduced into primary or secondary schools. They knew what was done in this way in France, and that very little was done in Germany. Another unsettled question was the relative advantages of apprenticeship schools, such as existed in France, and of the combined system to which he had referred, of work by day, and instruction in the evening. Then, as regards secondary instruction, there was the whole question of the value of science teaching, to which he had referred. Germany was looked to as the country in which science teaching was principally carried on, and yet a very eminent professor of chemistry in Germany had told him that he regarded it almost as nonsense to introduce chemical laboratories into secondary schools; it was quite sufficient for the pupils to receive instruction in the general principles of their science, the practice came soon enough. He need hardly say that he should give as much attention to these unsettled questions as he was able, and there were many others engaged in the same work. Meantime, any good teaching was better than none, and it was well that experiments in different directions were being tried. Those engaged in these experiments were giving their best thoughts to the question; and he believed that before many years there would be elaborated throughout the kingdom a system of higher scientific and technical education, which would favourably compare with any to be found in Europe.

Mr. CHRISTIAN MAST said the discussion, to a great extent, had taken the turn of surveying education in general, and he agreed with Mr. Magnus that scientific education could not be separated from education in general. As long as there was such a gap between the lower education and the higher, and so long as the two were not organically connected, the problem could not be satisfactorily settled. As a teacher himself, what could he do to promote technical education? He was bound to give that curriculum which public opinion demanded; the conductors of schools had to live, and they could not arrange their instruction on any ideal plan they might believe to be best; therefore, anything which would act on public opinion would do a great deal to solve the difficulty. There was one point about the technical education of the higher classes which seemed to have been lost sight of. In his native town, Wurtemburg, there was a school for the technical education of agriculturists, where gentlemen were instructed in everything relating to the science of agriculture; they paid high fees, and the course ranged over two or three years; and other establishments of a similar kind were scattered over Germany. One of his pupils was the son of a watchmaker; and as he wanted to have a complete practical and scientific education in watchmaking, which could not be obtained in England, when he had finished his education here he went to Geneva, where he would probably remain two years. The school to which he had gone was not exclusively technical, but took in a good deal of general education, and that was the case with many of the technical German schools. In Stuttgart there was a school for merchants, a *Handelschule*, to which his eldest son was gone, and there the instruction included not only things necessary for a merchant to know, but such as every gentleman ought to be acquainted with. As far as he knew, in none of the schools, not even in the *Polytechnikum* of Stuttgart, was the instruction merely technical. The great division was between the humanistic studies, which led to the university, and the realistic, which culminated in the *Polytechnikum*; and he thought it would be a great advantage if a similar division were observed in this country. It would not oblige him to teach Latin and Greek in his school, and at the same time, drawing, science, and mathematics. One branch of technical instruction ought to be taught to every child, and that was drawing, not merely freehand, but the use of the ruler and compasses.

Mr. LUCRAFT wished to say a few words from a workman's point of view. The great difficulty at present was to find a substitute for the apprenticeship system, and that might probably be found, if they set to work in the proper way. He did not approve of work being done in primary schools, it would be simply taking up time which ought to be devoted to other things. In connection with the London School Board, there were a number of scholarships given to boys and girls, to carry forward their general education, but he doubted if in many cases this did them any real good; and he should like to see schools established similar to that at La Villlette, where boys might have scholarships, which would really help them on in their after life. You might make a nation of professors, but if the artisan class was not instructed to do their work as it should be done, the nation would be very poor, although very learned. This was the kernel of the whole question, from the workman's point of view. The division of labour made men very clever at one particular thing, but in his own trade of a cabinet maker, when the old hands died off, those who were in the trade would be only those who worked at one small branch, and he did not think the cabinet work of the future would be equal to that of the present, which was equal to that ever produced in the world before. At the Paris Exhibition, people from all parts of the world expressed the opinion that some of the English work was the finest they had ever seen. When an apprentice was taught his whole trade, his intellect was at work, but a man who had to do one branch, whether it was cabinet making or anything else, could learn all he had to do, perhaps, in six months. This did not cause him to think, and he became more like a machine. In two Blue-books issued by the School Board, they had drawn out a scheme for technical education, whereby they could have some 3,000 or 4,000 boys continually at work in technical schools. The boys from the school at La Villette were sought for in the best shops in Paris, and became foremen, and many of them masters. The whole kernel of the question was how to make the artisan class what they ought to be in the future.

Mr. LIGGINS hoped the rich manufacturers of England would read this admirable paper, and take some action to endeavour to get a better education for their workmen and foremen, which he knew to be absolutely necessary. That afternoon he had been examining the finishing off of a new ship, and was talking to a foreman painter who had about two dozen men under him. He drew the foreman's attention to the fact that the work was not equal to that on first-class American ships, which he acknowledged to be the case, and said he wished he knew how it was done. There was the case of a man in a responsible position who did not know what was being done by our cousins across the water in his own trade, though he was willing to learn. In the clock trade there was only one school in London, and that was more a series of lectures than a school. England had lost the clock and watch trades of the world. Nearly all the time-pieces in the London shops were Swiss and French, and American Waltham watches were fast superseding, in the English workman's pocket, the Coventry watch. Again, with regard to painting, he could not but admire the beautiful works round the walls of that room, which showed no signs of cracking, but in the National Gallery, many of the pictures were decaying, and one of Sir Edwin Landseer's showed cracks all over, simply from an improper medium being used. Being personally interested in this subject, he had taken some pains to obtain the recipe given to the students of the Royal Academy, and he found it was diametrically opposed to that mentioned in the standard work published by the South Kensington authorities. Being perplexed between the two, he fell back on what was done four or five hundred years ago by Van Eyck, the inventor of oil painting, who had more knowledge than we had now, as shown by the perfect preservation of his pictures. We had also lost the art of wood-carving, for he had seen that day ships in which beautiful work of this kind was all being done by Italian workmen.

The CHAIRMAN said the question divided itself into two great branches, which had very little connection the one with the other. The one which had been chiefly treated in the paper was the education of the supervisors of labour, and to that the conclusion, quoted from the Conference of the Society, chiefly applied. He was proud to find that those resolutions still met with acceptance, and, indeed, he saw very little in them to change. All he could wish for was, that they should be more generally acted on. In all large towns there were now much greater facilities for acquiring scientific knowledge than existed twelve years ago, but the change had not gone on fast enough. What was chiefly required was not a new system, but more money, in order to endow more chairs, and so provide fresh professors with new museums. Establishments like King's College, University College, the Scotch Universities, the Victoria University, and similar institutions, in Liverpool, Dundee, and elsewhere, were proceeding upon well established and accepted lines, but they wanted, especially the older ones, more funds. They had one professor teaching two or three hundred students, instead of 20 or 30 men, as was the case in Germany. It was in teaching power for the upper and middle classes that Germany was so superior to England; but we could not simply copy Germany; the whole social arrangements were so different that that would be impossible. We ought to attain the same end by means specially congenial to ourselves. The question of the gymnasium as compared with the *Real-Schule* was a very curious and interesting one. About 12 years ago he travelled in Germany with the same object as Mr. Magnus and Mr. Robins, and found the same feeling there, but less strongly marked, that the pupil who had been trained upon the humanistic studies ultimately beat his competitor in scientific work. If that were a necessary effect it ought to be taken to heart, and they ought not too hastily to insist on the abolition of the dead languages as a means of training. The explanation which commended itself to his mind was, not that scientific teaching was really inferior as a means of mental discipline, but that it was much more difficult at present to find in Germany or in England men who were capable of using scientific teaching in that way, and he much feared that it would always remain so. For this reason Latin and Greek were dead languages and did not change; it was taught now as it was 50 years ago; but science changed with inconceivable rapidity, almost from day to day. What were the first fruits of science last year were already antiquated, and the difficulty was how to get a body of teachers who could follow all these constant changes at the same time that they were imparting instruction in secondary schools. He did not say it was impossible, but there was a great difficulty. After all, the personal influence of the teacher was of immense importance, perhaps quite as much so as the subject-matter taught; and if you had a man of broader culture and greater force of character, teaching Latin than the man who taught science, Latin would prove the best preparation for life. On the other hand, if the man who taught natural philosophy was the best man of the two, the boy who studied natural philosophy would probably turn out the best man; and really, in entering on special work, the character of the lad mattered more than the specific information he had acquired up to that time. As far as the higher education went, therefore, he thought the main thing was not the introduction of a little science along with Latin and Greek, but the establishment of several great scientific colleges, where the professors should be first-rate university men — enthusiasts, who believed there was nothing in the world like science, and that they would turn out men superior in every respect (including cricket), to the men from the old-fashioned schools, where they learned Latin and Greek. They would never get what they wanted while science was relegated to what was called the "modern side," and treated with more or less contempt. But while we had something to learn from the Continent in the matter of this higher education, with regard to the education of the artisan, which was of equal importance, nothing had been done in any part of the world whatever, except of the most rudimentary kind. His impression was that this would appear by the report of the Royal Commission. He could find nothing on the Continent twelve years ago, and though something had been done at La Villette, notwithstanding the eloquent picture drawn by Mr. Lucraft, he greatly feared it would be absolutely impossible to provide school training for the hundreds of thousands of working men in all the numberless sub-divisions of their trades. If there were others who took a different view, let them try by all means, and see how their scheme would grow. That was the real test in England; everything that had organic vitality would grow and develop. They all agreed that the work could not be done by the Government. He held very special views upon this subject, which at that late hour it was impossible to develop; and he would only say generally that he held that the education of the workman could be greatly improved by a systematic supervision of the manner in which work was done in the workshops themselves; and that this supervision might be carried out by the co-operation of the employers and the men. This might seem a very Utopian scheme, and he could not explain the details by which he thought it might be worked out, but they would all agree that there existed in this country the material for giving the best technical education in the world, and, therefore, all that was required was organisation. Instead of the workman being left to himself or to the tender mercies of capital, he should be guided, superintended, and rewarded; but this superintendence and organisation could not be carried on from without, but must be undertaken by those who were personally interested in the matter, and who had specific knowledge of the trade itself. He would conclude by proposing a vote of thanks to Mr. Robins.

The vote having been carried,

Mr. Robins said he was extremely gratified by the discussion. There was no doubt that the competition between nations was increasing every day in this question of technical education, and, therefore, its importance could hardly be overrated. It was true, as Professor Perry said, that those who did not take advantage of technical education when they might did not deserve pity; but his object was to see whether the information he had collected would throw any light on the cause of the great difference which seemed to exist in the amount to which technical education had profited one country, and not another. The difference in the primary education did not seem to give the clue, but when he examined the provisions in foreign countries for higher education, he found something so superior to anything in England, that he thought a lesson might be learned from it. Whatever was done for working men, there must also be something done for those who might help themselves but did not, to make the difference between England and foreign countries less perceptible than it now was. The City Guilds had not said that this, or that, and nothing else, should be done. They were all learning, from day to day, but he was sure all would rejoice that something was really being done. He would not say much about the advantages of classical education, which had been so well discussed by the Chairman; but he did feel that if Latin and Greek were dead languages, and no new life could be got out of them, there was not much preference to be given to such mediums for the expansion of a man's mind. On the other hand, that which was growing every day so fast that there were not teachers to be found to teach it, would seem to be calculated to enlarge and expand the mind much more than a dead language could possibly do. Without good teachers, of course, they could not expect much improvement; but there were teachers in Germany who took these things to heart earnestly, and good scientific teaching was going on there to a much greater extent than it was here.

CATALOGUE OF THE EXHIBITION OF MODERN ENGLISH POTTERY.

I. T. C. Brown-Westhead, Moore & Co., Cauldon-place, Staffordshire Potteries:—

1. Two large "ivory" vases, with raised birds and flowers, in gold and silver.
2. Two "ivory" plaques, with raised birds and flowers.

II. Henry Doulton & Co., Potteries, Lambeth, S.E., and Burslem, Staffordshire:—

Collection of Doulton Ware of various kinds.

a. Salt-glazed decorated stoneware. The decoration consists of incised, modelled or applied work, naturally or conventionally treated, with figure and animal subjects, including candelabra supported by figures, perforated vases, modelled dragons, pedestals, &c., and specimens of animal subjects, by Miss H. H. Barlow; and figure subjects representing fables, &c., by Geo. Tinworth. Fired in the open kiln.

b. Salt-glazed *pâte sur pâte.* The decoration being produced by coloured clays or slips laid on and modelled with the brush. This is also burnt in the open kiln.

c. The new Silicon ware, with modelled, applied, and *pâte sur pâte* decoration.

The whole of the above wares are subject to one firing only.

d. Modelled terra-cotta panels. Sketches in high relief, by Geo. Tinworth.

Collection of Earthenware.

a. Conchoid decoration.
b. Raised flower ,,
c. Underglazed painted work, with celadon and other bodies, and bronze, silver, gold, and clouded backgrounds, in vases, jugs, plaques, &c.

Collection of Lambeth Faïence and Impasto Wares.

a. Lambeth faïence, decorated in underglaze, with or without over-glaze finishing, consisting of landscapes, floral and conventional ornaments, and figure subjects in vases, plaques, tiles, &c.

b. Impasto ware, in coloured slips, with floral decoration, burnt in underglaze kilns.

III. JOHN HARRISON, Linthorpe Pottery Works, Middlesbrough-on-Tees, and 85, Northgate, Darlington:—

Specimens of Linthorpe ware, consisting of vases, plaques, flower-pots, tazzas, card trays, fruit dishes, &c.

This ware is made largely from the ordinary red clay found at Middlesbrough-on-Tees, and is distinguished by the variety and richness of the glazes and colour effects.

IV. MAW & CO., Benthall Works, Broseley, Shropshire:—

Specimens of painted tiles and tile panels.

Vases, jugs, tazzas, &c.

V. MINTON'S China Works, Stoke-on-Trent:—

Selection of Vases, Cups, Plates, Plaques, &c.

Specimens of *pâte sur pâte* decoration.
Copies of Henri Deux ware.
Imitation Sèvres porcelain.
Imitation lacquer work.
Prometheus vase.

VI. JOSIAH WEDGWOOD & SONS, Etruria, Stoke-upon-Trent. (Charles Bachhoffner, Agent, St. Andrew's-buildings, St. Andrew's-street, Holborn-circus, London, E.C.):—

1. A Swan vase, blue underglaze, painted by T. Allen, "David before the Ark," "Delilah and Samson," and "Marianne."
2. A pair of Renaissance vases, coloured underglaze, by T. Allen, "Nymphs and Amours."
3. A pair of vases, china, turquoise, painted by T. Allen, "The Pets."
4. A vase and pedestal, black and white jasper, "Bacchanalians."
5. A vase, black and white jasper, "Pegasus, with subject of the Apotheosis of Homer and Virgil," being a reproduction of the old vase and pedestal recently sold at Christie's for 700 guineas.
6. The Portland Vase. Being one of the subscription fifty now being published at 40 guineas each, produced and finished in the same manner and perfection as the original subscription copies by Josiah Wedgwood, since whose time the completing process of polishing and tinting has not been attempted until now.
7. Specimens of Wedgwood jasper ware vases and plaques, &c., in pale blue and white, dark blue and white, sage green and white, black and white, black basalt, &c., from the models and moulds by Flaxman.
8. Busts in black basalt, "Faun," "Venus," "Washington," and "Seneca."
9. Specimens of Wedgwood China. China, until recently, has not been made at Etruria since the beginning of the century. The great influx of orders for "Queen's ware," and "Wedgwood ware," after the Napoleonic wars and the peace of 1815, was so great that the whole of the works had to be applied to their production. Recently, new works having been added to the original establishment, the firm are able to again add china to its productions.
10. Specimens of "Wedgwood Victoria

bas-relief," a new form of manufacture, from the original models by Flaxman, and produced from his original moulds, but decorated in colours, glazed and gilt in accordance with the taste and requirements of the present day.

11. Specimens of ware for domestic purposes, in cream colour or "Queen's ware," and white and in china.
12. Specimens of useful ware, and ware for electrical and other similar purposes.
13. Specimens of the plaques, in sage green and white jasper, recently made for the Earl of Aberdeen, for two chimney-pieces, in Haddo-house, Aberdeen. Also others, in blue and white, for the same. Lord Tweedmouth says of these plaques and medallions, that they are capital copies, sharply and artistically cut, of the originals in his library and drawing-room, which are considered masterpieces of "Wedgwood's" best period.
14. Specimens of the plaques, medallions, &c., used in the decoration of Lord Dysart's mansion, at Buckminster-park, Grantham, now in the course of reconstruction by Mr. Halsey R. Ricardo, architect, of 13, Bedford-square. The whole of the rooms are decorated with string courses of Wedgwood ware, and medallions and plaques are introduced into the chimney-pieces and panels, and the clocks are of solid jasper fronts. Vases are also introduced as part of the architectural decoration.
15. Two plaques, painted by L. M. Lessore.

VII. WORCESTER ROYAL PORCELAIN COMPANY, Worcester. (London Show Rooms, St. Andrew's-buildings, St. Andrew's-street, Holborn-circus, E.C.):—

Collection of vases and decorative objects with specimens of services, showing the various classes of decoration now in use at the Worcester Royal Porcelain Works.

1. Vase, Persian shape, fine raised gold.
2. ,, pierced corners, metal decorations.
3. Ewer, Persian decoration.
4. Vases, imperial red & modelled golds.
5. Vase, metallic decoration.
6. ,, Persian, celadon and platinum and gold decoration.
7. Ewer, pencilled ivory, and gold and red.
8. ,, pencilled ivory and dry colour, Persian scroll.
9. ,, copper and fine raised golds.
10. ,, Persian scroll.
11. Vases, pencilled ivory and modelled golds.
12. Leaf, ditto.
13. Bowl, ditto.
14. Jug, dragon-handle and ditto.
15. ,, turquoise and gold geranium leaves.
17. Fan, gold panel and painted birds.
16. ,, metal decoration.
18. Vase, Persian and metal decoration.
19. ,, ,, ,,
20. ,, pencilled ivory, and coloured and gold.
21. Persian forms, metallic decoration.
22. Tapers, Japanesque, gold and red.
23. Elephant.
24. Cruche.
25. Vases, coloured and gilt leafage.
26. Group of tubes.
27. Vase, painted lotus.
28. ,, iron and platinum, and dry colour spray.
29. Triple metal decoration.
30. Single metal decoration.
31. Jug, Persian, gold sprays and flies.
32. Vases, Persian, pierced, decorated.
33. Figures, bronze.
34. Japanese kettle.
35. Kettle, fluted.
36. Vases, metal ground, painted lotus and dry colour.
37. Spills, metal decoration.
38. Globe vase, sprays and clouded golds.
39. Spill, ditto
40. Vase, platinum and gold decoration.
41. Dagmar horn, iron and platinum, and gold and red.
42. Coffee cups and saucers tankards.
43. Coffee cups and saucers.
44. Dessert plates.
45. ,, basket pierced.
46. ,, square metallic, storks and sprays.
47. ,, blue, diaper, celadon, &c.
48. Tea cups and saucers.
49. Bowls and saucers.

Miscellaneous.

FORESTRY IN GREAT BRITAIN.

The following is an abstract of the report made by M. Boppe, Inspector of French Forests, to the India Office:—

The total area of Scotland is about 20,000,000 acres, hardly one quarter of which may be reckoned as arable, forest, or pasture land, the remainder being occupied by the lakes, rivers, peat-mosses, moorlands, bare rocks and mountains. It is surprising then to find that against such a vast area of uncultivated ground only 734,490 acres, according to the official returns of 1872, are classed as woodlands.

There is every reason to suppose that, at a remote period, both the Highlands and Lowlands of Scotland were covered by dense forests, which were successively destroyed by the fire and steel of conquerors, and during the anarchy existing under the old feudal system, as well as by the fearful storms which at almost regular intervals sweep over certain districts. So complete, indeed, was this devastation, that, in in 1707, all that remained of the grand old Caledonian forests were a few shreds, and those in a most deplorable condition.

Under the wise patronage of the "Select Society" of Edinburgh, founded in 1754, the area of forest land augmented rapidly, so that, in 1812, Scotland possessed, besides 500,000 acres of natural forest, about 400,000 acres of plantations.

The year 1815 marks a pause in the work of replanting which had been so vigorously begun.

The returns of 1872, as compared with those of 1812, show a diminution of some 200,000 acres in the area of forest land in Scotland. Whether it was a portion of the old natural forest or the newly planted ones that had disappeared during this period of 60 years, the documents extant do not show. There is, however, good reason to suppose that both suffered equally in this respect. For, on the one hand, the construction of the Highland Railway necessitated the employment of a large number of sleepers, which could be procured from the woods of from 50 to 80 years of age, along the line of route; and, on the other hand, the increased facilities of transport, and the scarcity of wood in England, gave an unexpected value to certain tracts covered with birch, and so tempted many of the proprietors to cut down the old forests composed of this species.

In 1870, the work of replanting seems to have recommenced with increased ardour, and on all sides may be seen young plantations vigorously striving to fill up the gap which separates them from those of half a century's standing.

From a forest point of view, Scotland may be divided into two distinct regions, by an imaginary line drawn from Perth, on the Firth of Tay, to Greenock, on the estuary of the Clyde. To the south of this line we find the Lowlands, a country which agriculture and manufactures have combined to render one of the richest in the world. The economic situation of this wealthy district is as prosperous as possible, and the thoroughly developed system of high farming which is there employed leaves but little room for forest cultivation. The Lowlands are bounded on the south by the Cheviot Hills, which afford excellent sheep walks. To the north of this line lie the Highlands, intersected in all directions by the far-stretching chain of the Grampians, whose rugged nature gives to the country an aspect not unlike that of the western coast of the Scandinavian peninsula. One would imagine that at some earlier geological period immense polar glaciers, flowing over the solidified North Sea, traversed the whole of the north of Scotland, polishing on their way the mountain sides, excavating the lake beds, and breaking off abruptly the cliffs surrounding the coast. The culture of cereals is here confined to a few favoured localities, situated near the mouths of the rivers or on the low-lying ground bordering the sea, where the glacial deposits constitute an excellent soil. The rest of the country is wholly occupied by water and heather, and thus out of the 13,000,000 acres which this region comprises, only 1,600,000 (or less than one-eighth) are classed as arable, forest, and pasture lands. If out of the remaining 11,000,000 acres of unproductive land we allow a half for the lakes, bare ridges, and sterile mountain tops, there will still remain 5,000,000 acres capable of furnishing valuable timber forests. Here, then, is a problem for British economists, and a vast field for enterprise and capital.

In the Highlands, to which we principally directed our attention, the districts around Perth, Elgin, and Inverness, are those in which the most extensive forests are to be found. These three counties together contain about 247,700 acres of forest, and being well served by the Highland Railway system, these are easier to visit than any of the other Scotch forests. Starting from Perth, we made our way across the Highlands, visiting *en route* the towns of Dunkeld, Blair Athole, Aviemore, Grantown, Forres, Inverness. and Beauly. We were thus enabled, not only to make an inspection of some of the finest forests in Scotland, but at the same time to obtain a fair idea of the general aspect of the country.

In the low-lying districts, at an altitude of from 250 to 300 feet, we found growing, both singly along the roadside, and collectively in the forests, magnificent specimens of oak, maple, elm, ash, beech, and lime, which, by the vigour of their growth, and the rich colouring of their foliage, bore testimony to the favourable conditions of soil and climate under which they grew. We were struck with admiration in beholding the colossal trees of every description forming the avenues at Scone, Dunkeld, Blair Athole, and Darnaway. It was near the first of these places that the venerable father of Scotch forestry, Mr. McCorquodale, showed us, with legitimate pride, a small oak forest of about 400 acres, which, 60 years before, he had himself assisted to plant. In this forest, the trees were standing about 24 to 30 feet apart, and their diameters measured from 12 to 18 inches, whilst their magnificent tops formed a perfect canopy of leaves above the bright rhododendrons, in which colonies of young pheasants found a home. In the spring time this ought indeed to be a fairy-like spot. But, independently of this undergrowth, which is, after all, only suitable for the wealthy few, we cannot help thinking that a more careful study of this superb forest would go far towards clearing up some of the doubts which have always surrounded the difficult question of the cultivation of forests composed solely of oak.

The mountain vegetation commences at about 400 feet above the level of the sea; beyond this we find ourselves in the domains of the Scotch fir, the larch, and the birch.

In selecting the Scotch fir as the tree to be cultivated before all others in these regions, the promoters of forest plantation, during the latter half of the past century, showed no mean proof of their thorough appreciation of the natural requirements of the soil and climate of the Highlands, for not only have they ensured the success of their operations, but they have traced out the best line of action for their successors.

Equally fortunate were they in their endeavour to introduce the larch into Scotland; transported from the ice-bound summits of the Alps to a country where the climate is tempered by the softening influence of the Gulf Stream, this tree does not appear to have suffered to any material extent by so sudden a change of latitude.

When, in 1737, the Duke of Athole brought home, amongst his baggage, as a kind of remembrance of his travels in the Tyrol, the seeds which were sown in his park, and from which sprung the first larches in Scotland, he rendered a most valuable service to his country.

From a forest point of view, the results obtained by the cultivation of these two species (Scotch fir and larch), are truly marvellous. Any one who has seen the beautiful larch forests planted in 1815 on the banks of Loch Ortie and the vast stretches of Scotch fir covering the flanks of the Bruarwood Mountain, cannot fail to admit that the question of the replanting of the Scotch Highlands is practically answered.

The absence of the beech from all the forests of any standing is easily accounted for by the fact that it is only quite recently that the timber of this tree has become of any value for industrial purposes. For many cultural reasons, however, the beech is a tree of the highest importance, and we should strongly recommend its introduction into all future plantations, and it is, morover, as much indigenous as the Scotch fir and birch. In many cases even it might with great advantage be substituted for this latter, or, better still, mixed with it.

Considering, too, the wonderful success that has attended the introduction of the larch, we think that a similar attempt might be made to acclimatise the *Pinus montana* in the peat mosses.

We were also struck by the monotonous regularity in the height and age of the trees, unmistakable sign of their artificial origin, and want of methodical management. The forest, here left to its own devices, continues growing just as the hand of man has planted it; the undergrowth is constantly grazed down by the sheep and cattle, and nature, in spite of the immense resources at her disposal, is quite powerless to modify the work of the planter, or repair the errors committed by woodcutters.

When, under such circumstances, the time arrives for the trees to be cut down, or should they be uprooted by a hurricane, the forest disappears in its entirety, owing to the total want of young growth which is necessary as a link between the old forest and the new one which ought to be created. Such, at least, appears to us to be the case in all the forests that we visited in the valley of the Tay and its tributaries, and further north, near the foot of Cairngorm.

It is an established fact, beyond all contradiction, that on any soil, whatever its geological origin, a complete covering of forest vegetation will kill the heather as soon as the trees reach the age of between 30 and 40 years. Suppose, then, that 120 years be the term fixed for the existence of the trees in any portion of the forest, and that the trees of 100 years and over are reserved, there would still be one half of the forest always open to the sheep, and the other closed. But, at the same time, it is certain that this open half, owing to its superior quality, will furnish pasturage for at least twice as many head of cattle or sheep as the same quantity of moorland.

Although, under ordinary conditions, the regeneration of a forest will be sufficiently assured by the exercise of a discreet control over the grazing, something more than this must be done if it is desired to turn the land to the best possible account. It is, therefore, a matter of regret that nothing has been done to place forest management in Scotland on a sound economic basis.

The productive powers of the soil and of the climate have been made use of by able and intelligent planters, who have thereby enabled nature herself to accumulate a considerable store of timber; but all this wealth is exposed to the carelessness of some and to the ignorance of others, until the hand of a forester manages it properly, and places it on the only sound economic principle of all agricultural and forest property—a constant annual revenue, and a constant improvement in production.

No doubt people are often frightened by the long names and big words they find in treatises on scientific forest management, but they may very well neglect the text if only they will adopt some of the principles which they contain. Let the owner of a forest, after having made a careful and detailed inspection of it, divide it off into blocks or compartments, so arranged that they should be uniform as regards conditions of soil and of planting, and then proceed to count and measure all the trees of three feet girth and upwards, classing them in categories according to their diameter. He should then open a debit and credit account for each compartment, placing on the debit side the actual volume of the standing crop, and on the credit side the volume of timber removed at each successive felling. The register should always be consulted before undertaking any forest operation, and when the annual fellings fall due, it will show which compartments can best support the withdrawal of timber, and which require to be left untouched. Moreover, the balance-sheet will render an exact account, favourable or otherwise, of the condition of the forest.

Ten years of such systematic treatment would form in itself the basis of a regular forest working plan, and the doctor's prescription would no longer frighten the patient with his long words.

Windsor Park is indeed one of the most magnificent fields for the study of forest botany that even the wildest imagination could conjure up. Here may be seen, growing singly or collectively in clumps, specimens of all the finest trees, native or exotic, which exist in Great Britain; and, since care has been taken to keep an exact record of the age and origin of each plantation, the forester would be enabled to follow out in detail studies of the highest interest and importance regarding the growth of the principal forest species. It would be more difficult to do the same with regards to their longevity; for one is led to think, in looking at some of them, that, in this hallowed ground, trees never die of old age. One sees in these relics of the past, that religious respect for things so characteristic of Englishmen, when even the most violent revolutions could pass over the country and yet leave these monuments and these trees intact.

New Forest.—For many centuries the New Forest has been a prey to commoners, who use up its resources without either method or control. One may see there the steady onward progress which is made by the heather; and although it is not perhaps so quick under the feet of the almost wild ponies and cattle as under those of the sheep, yet it is none the less sure.

The sole remedy for this state of things was to restrict the commoners to certain defined localities, and that could only be done by sacrificing a portion of the forest to save the rest. This is, in fact, what was done about twenty years ago; but the sacrifice has indeed been a heavy one, for the reservation of some 14,000 acres has cost the abandonment of 49,000 more. The part which has been freed, however, is sufficiently extensive to constitute some day a respectable forest, whilst the part given up is hurrying to its destruction in a manner deplorable to behold, and, before very long, there will be nothing left but a worthless barren heath.

Without contesting the marvellous beauty of some parts of the New Forest, so dear to artists and lovers of nature, we are bound to say that before long it will not be here that a professor of sylviculture, desirous of teaching his science, will choose to pitch his tent.

Forest of Dean.—The present Forest of Dean occupies the site of the old forest of the same name, which formerly covered the whole of the plateau between the estuary of the Severn and the valley of the Wye ("Dean," "dên," signifies "forest" in the old Celtic language.) The old forest has disappeared within the last few centuries, owing perhaps to the demand for charcoal and mine-props for the local industries; if, however, we were not afraid of being accused of being prejudiced, we might say that unrestricted pasturage may have had something to do with the disappearance. It is on these rules that the new Forest of Dean has been created; in less than a century, more than 16,000 acres of the original 22,000 have been replanted. The older plantations are generally of pure oak; the beeches, chestnuts, and birches form but a small per-centage of the trees. Scotch fir, spruce, fir, and larch, are generally only found in the plantations made during the last 30 years, or in bad peaty portions. The state of vegetation is generally good, varying, however, with the quality of the soil, but indicating in every point the artificial nature of the forest.

We may take this opportunity of remarking that a plantation of "broad-leaved" trees (oak, beech, &c.) takes a much longer time to establish itself than one of the "needle-leaved" trees (conifers, Scotch fir, larch, &c.). In Scotland we saw the most magnificent plantations of larch and fir, whilst in the Forest of Dean the plantations of oak were always more or less dwarfed in appearance. The cause of this is that oaks furnish the soil with much less vegetable manure than the coniferous trees; and again, in an oak plantation there is a marked absence of undershrubs and spontaneous ground vegetation, which, by their organic remains, tend to increase and improve the surface soil. It is rare also that a plantation of oaks, on a soil which has been long unoccupied by forest vegetation and is but moderate in quality, succeds well during the first generation; it is only at the second generation that the trees acquire their normal development.

At present, while the trees are yet in their youth, the only cultural operation that can be undertaken are the periodical "thinnings," and these are here conducted with great skill. There is, no doubt, however, a future in store for the Forest of Dean, thanks to the workmanlike manner in which it is managed, and to the laws regulating the pasturage, which date back to the time of Charles I.

In answer to the question whether the immediate foundation of a Forest School in Great Britain is possible, M. Boppe went on to make the following recommendations:—After making every allowance for the great fertility of the soil in Great Britain, we feel certain that in many districts more than one of the forests which were cleared some time back would now be jealously preserved by the same proprietors who formerly cut them down to satisfy their pressing wants.

It must also be borne in mind that the British Empire is not confined to Great Britain and Ireland, and that, by reason of her immense possessions, England is, perhaps of all nations in the world, the one most richly endowed with valuable forests. It is by hundreds of millions of acres that we may reckon the forests of Canada, India, and Australia, New Zealand, and Cape Colony, not to speak of those in the West Indies and Borneo.* All these natural sources of wealth are worked by British enterprise and British capital, and, consequent on the present wonderful development of commerce throughout the globe, it is a matter of importance to every civilised nation that this vast accumulation of forest riches should not fall into the hands of ignorant persons, or be squandered away, regardless of the future.

For these reasons the establishment of a Forest School in England becomes a matter of primary importance.

The science of forestry is, however, a science of observation, based upon facts which must be studied both from a practical and theoretical point of view. It is therefore absolutely necessary that a Forest School should have attached to it a forest which has for some time past been under scientific management, serving, so to speak, as a natural laboratory for experiments, and without which the best theoretical teaching in the world would be of no avail.

It is necessary also to take measures for preparing the public mind to regard the science of sylviculture as an additional means of developing the national resources, and to take steps for the gradual creation of accessory forests.

This accessory forest must necessarily be incomplete at first, but would be perfected in time; but the essential point is that it should be placed under the absolute control of the officers of the school. This can only be done by choosing a State forest. If it should be considered desirable also, in order to render the teaching more complete, the State ought to purchase or lease in Scotland a forest suitable for the purpose.

We would also suggest the founding of Professorships of "Forest Economy" at two of the great public seats of technical instruction. One of these might be instituted at Cooper's Hill for England, the other at Edinburgh for Scotland.

The Professors should be selected from among the young men who have received a thorough forest education on the Continent, and have had eight or ten years' practical experience in India. They should publish from time to time a series of articles in the leading agricultural and forest journals, in order to influence the landowners in favour of a systematic management of their woodlands, and to prove to them that uncontrolled pasturage is the certain destruction of forests, and that, in the long run, the timber furnished by forest land is of greater value than pasturage or game.

In conclusion, we beg to submit the following recommendations:—

1st. That a National Forest School be founded in Great Britain.

2nd. That Professorships of Sylviculture be instituted at Coopers Hill, and at Edinburgh.

Such are the conclusions at which we, in conjunction with our travelling companions, Messrs. Reuss and Bartet, have arrived, and we feel that an apology is due for their length. This is really due to the excessive courtesy of our hosts, who, jealous of the success of Jules Verne's hero, who made the tour of the world in 80 days, were determined to make us traverse, in less than three weeks, more than 300,000 acres of forest land situated in the most opposite parts of Great Britain, from Cape Duncansby to St. Catherine's Point.

General Notes.

Census of Victoria.—Mr. H. H. Hayter, the Government Statist, has drawn up a table, showing in detail the birthplaces of the people of Victoria as returned at the census taken on the 3rd of April, 1881, from which it appears that out of the total population of 862,346—499,199 persons were born in Victoria, and 282,349 persons in the United Kingdom. The remainder of the population was made up of persons born in a great variety of other countries. Of these, the largest number were:—11,876 born in Tasmania, 8,571 in Germany, and 11,799 in China.

Manufacture of Artificial Parchment.—Messrs. Herold & Gawalowski, of Bruun, make as follows, a strong, artificial parchment, impermeable by water, and capable of serving for the diaphragm in osmotic operations on solutions of impure sugar, &c. The woollen or cotton tissues are freed, by washing, from the foreign substances, such as gum, starch, &c., which may cover them. They are then placed in a bath slightly charged with paper-pulp; and to make this pulp penetrate more deeply, they are passed between two rollers, which slightly compress them. The principal operation consists in steeping the product for a few seconds in a bath of concentrated sulphuric acid, after which it undergoes a series of washings in water and ammoniacal liquor, until it has lost all trace of acid or base. It is then compressed between two steel rollers, dried between two others, covered with felt, and finally calendered, when they are fit for use.

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* The total extent of the forests in the British possessions is 340,000,000 acres of timbered land.

Postal Statistics.—It is estimated that, in 1879, 5,815 million letters, packets, &c., were posted in Europe, of which the letters and post-cards formed 66·6 per cent.; newspapers, 22·8 per cent.; and printed matter and samples, 15·6 per cent. The proportion contributed by England is the largest of any country, being 27·4 per cent.; after which in order come Germany, 23·8 per cent.; France, 19·8 per cent.; Austria-Hungary, Italy, Russia, Belgium, Switzerland, and Holland, with Luxemburg and Bulgaria last. An Englishman, on an average, writes a letter or post-card every 10 days, a Swiss every fortnight, a Wurtembergian every 18 days, a German every 20 days, and a Roumanian only one in every 300 days. The total number of telegrams sent within the limits of Paris alone, in 1880, is 969,177, having increased nearly threefold in four years. Of this number the pneumatic telegrams, inaugurated in 1879, amounted to 458,245, that is to say, 334,445 telegram cards, and 123,800 closed telegrams. It has frequently been found that a lowering of the tariff immediately caused an increase in the number of telegrams, and therefore of the receipts. On 1st June, 1880, the cards were reduced from 50c. (5d.) to 30c. (3d.), and the closed telegrams from 75c. (7½d.) to 50c. (5d.), with an immediate increase in the numbers.

The Reclamation of Waste Land in Italy.—A Bill has again been brought before the Chamber of Deputies, for the improvement of marsh lands, and the project of the Commission has excited great interest. It is proposed to establish corporations of capitalists that will secure a return for their outlay by the difference in value of the land after the drainage and irrigation works have changed its capacity for production. Every one who has visited Italy cannot fail to have been struck with the vast extent of marsh and waste land in that country. From Genoa to Rome, the traveller is impressed with the fact of how much greater might be the production of this fertile country were it in the hands of the Dutch or English. With the decay of ancient civilisation in Italy, vast tracts of land were allowed to slide back into dark morass and wilderness, noxious to any centre of population in the vicinity. Theorists have long calculated the difference of death-rate likely to be brought about at Rome by the drainage of the Pontine marshes. The success attending the labours of the Trappist monks, on a small scale, in the Roman Campagna, is well known; blooming and fertile gardens have taken the place of barren waste, and insalubrious tracts have been converted in a short time, if not into healthy localities, at least into districts where human life is possible.

MEETINGS OF THE SOCIETY.

Wednesday Evening, at Eight o'clock :—

May 31.—"The Gold Fields of West Africa." By Captain Richard Burton.

Indian Section.

Friday Evening, at Eight o'clock :—

June 2.—"The Production of Tea, Cinchona, Rhea, and Wild Silks, in India." By J. R. Royle. Andrew Cassels, Member of the Council, in the Chair.

MEETINGS FOR THE ENSUING WEEK.

Tuesday, May 30...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "Digestion." (Lecture III.)

Wednesday, May 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain Richard Burton, "The Gold-fields of West Africa."

Public Analysts, Burlington-house, W., 8 p.m. 1. Dr. J. Muter, "A Fat recently extensively sold for the Adulteration of Lard." 2. Mr. F. P. Perkins, "Discordant Milk Analyses." 3. Mr. J. W. Gatehouse, "The Composition of the Black Deposit which forms on the Electrolysis of Saturated Solution of Silver Nitrate." 4. Mr. G. W. Wigner, "The Work done by Public Analysts during 1881, under the Sale of Food and Drugs Acts."

East India Association, 14, Bedford-row, W.C., 3 p.m. Mr. W. Pirie Duff, "Indian Trade and Finance—Past, Present, and Prospective."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Thursday, June 1...Linnean, Burlington-house, W., 8 p.m. 1. Mr. Marshall Ward, "Results of the Investigations on the Ceylon Coffee-leaf Disease." 2. Dr. G. Foggan, "Cutaneous Nerve Terminations in Mammals." 3. Mr. H. C. Levinge, "Himalayan Ferns." 4. Mr. H. Sorby, and Prof. Herdman, "Some British Ascidians." 5. Mr. T. Kirk, "New Additions to New Zealand Flora." 6. Mr. F. W. Phillips, "Animalcule Allied to Pleuronema." 7. Mr. P. H. Carpenter, "New Comatulæ."

Chemical, Burlington-house, W., 8 p.m. Dr. Russell and Mr. Lapraik, "The Spectroscopic Study of Chlorophyl."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Metals." (Lecture VII.)

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Friday, June 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. R. Royle, "The Production of Tea, Chinchona, Rhea, and Wild Silks in India."

Royal United Service Institute, Whitehall-yard, 3 p.m. Lieut. Chas. Sleeman, R.N., "The Defence of Harbours by Captain McEvoy's Improved System of Defence by Electrical and Mechanical Submarine Mines."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. H. H. Statham, "The Intellectual Bases of Music."

Philological, University College, W.C., 8 p.m.

Saturday, June 3...Royal Institution, Albemarle-street, W., 3 p.m. Professor D. Masson, "Poetry and its Literary Forms." (Lecture III.)

Institute of Actuaries, The Quadrangle, King's College, W.C., 3 p.m. Annual Meeting.

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FRIDAY, JUNE 2, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Exhibition was opened on Wednesday, 24th inst., and will remain open every day from 10 to 4 (Saturday 10 to 2) until Friday, 30th June. Members of the Society are admitted on signing their names, and can admit friends either by use of the tickets supplied for the evening meetings and lectures, or of their visiting cards.

A catalogue of the Exhibition was given in the last number of the *Journal*.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 14th June. The cards of invitation are in course of issue.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 23rd; Lord Alfred S. Churchill, member of the Council, in the Chair.

The SECRETARY announced, that through a sudden attack of illness, Captain Burton was prevented from reading his paper, and that, in consequence, Captain Cameron had kindly consented to deliver an address himself instead of, as he had intended, supplementing the paper which Captain Burton had prepared, and for the reading of which another evening would be found.

An address was then delivered on—

THE GOLD FIELDS OF WEST AFRICA,

By CAPTAIN CAMERON, R.N.

It is very awkward for me to get up now, to speak on this subject, which should have been treated of only in connection with Captain Burton. He and I have been travelling together, and there never was a more loyal friend or better companion than he proved himself to be. We had arranged that his paper should be prepared by to-night, and that I should make simply a few remaks; and we hoped afterwards, at the Geographical Society, and other places also, to tell our stories in different ways, each taking his turn. The paper was written. I do not know whether anyone here knows Captain Burton's writing. I can read it perfectly when I receive his letters, but to read it on an occasion like this would be difficult, especially as it is scored and corrected in many places.

As I only had notice of the change of the arrangements at five minutes past seven, you must excuse what faults I make in telling you the story of what my friend, Richard Burton, calls the Old New California. There are things here which I should have wished Captain Burton to have explained to you—as the first Chairman of the Anthropological Society—stone implements from Africa, found in our travels, and other things; and I have the deepest regret that you should be assembled here to-night to listen to me, instead of to the most accomplished traveller of this or any other age.

Captain Burton and myself, last year, when we met at the Geographical Society, had very grand ideas about the journeys we might make. We sent out for a number of men to be ready to go with us; but when we got to our field of work, instead of about 170, we found only 7, and this rather crippled our plans. I cannot say to-night everything I wish to say, as effectively as I desire; but acting under a man like Captain Burton, I was able to do better work than I could otherwise have accomplished.

I left England a short time ago—on the 31st of December, and on the 9th of January, at Madeira, Captain Burton met me. We passed down the African coast in the usual way; we touched at Gambia—Gambia, one of our oldest possessions; Gambia, where gold was found at one time; Gambia famous in many ways. What did we see there? We saw Chinese rice being landed from a Liverpool steamer, to feed a population where the finest rice-growing ground in the world exists. We found a false idea of economy prevailing. In the Government House, the paper in the rooms is peeling off the walls; there is a sentry outside, with a pair of green carpet slippers on, and other things of that kind. This is the outcome of the false economy, and that with a very large amount of money in the chest. At Sierra Leone, matters were better; but the Sierra Leone negro has an idea that the moment he has got four or five shillings or so, he has nothing to do but to buy a big basket, and start as a merchant. The natives here look upon agricultural labour as being beneath them. This is one of the richest of countries, and, with proper labour, an enormous trade might be done with this country. It is not the fault of our Government; it is the fault of the people themselves, more or less. I found the same thing in Central Africa: the people go in for trade more than for anything else. I do not want to say anything against them. They think that they are raising themselves, and it is a noble idea that they should raise themselves; but the fact remains that it is not for the benefit of the country they should do it in the way they now make the attempt. We passed down the coast, touching at different ports, and arrived at Axim. There we were cordially welcomed by the agents of Messrs. Lintott and Spinks, and of Messrs. F. and A. Swanzy, and every facility was placed in our way. The Kroo boys we expected to be retained for us at Cape Palmas not being ready, as I said before, we had to think of what we should first do.

First of all on our programme was a visit to the Israh mines in Appolonia. These mines have been taken in hand by a company; they are part of the dominions of King Blay, who, when nearly every other native chief, during the Ashanti war (I do not mean the Ashanti scare), was against us, held his people together and defended himself, and fought for us bravely and like a man. King Blay came to call upon us, carried by four sturdy knaves in a thing like a buck basket lined with red cloth. He wore on his head a general's cocked hat, with a towering plume of white and red feathers, which had been presented to him by our Government, his general's sword, and his Ashantee medal; and in each corner of the basket in which he was carried was one of his gold-hilted swords, which are the emblems of royalty. He descended from his vehicle, and he and some half-dozen of the principal chiefs came into our room and sat on chairs, whilst other people sat round about to listen, as part of his retinue. The African piano on the table is a specimen of one of the musical instruments. There was also a war drum, hung round with skulls, in fact a fetish drum. There was another drum covered with leopard skin, which, instead of being beaten, was scraped. There were court criers, who sang out all the king's *strong names*:—"This is King Blay; King Blay is a conqueror; King Blay is a strong man;" and each time he answered: "I am here; I am King Blay." This was simply a formal call, and soon afterwards he came divested of all his gorgeous robes. He, before, wore a violet silk—now, a calico cloth, and about the seediest hat a man could ever see on his head, which seemed to be one of the distinguishing marks of chiefs of high degree. He spoke about our going out to visit him at Abuta, his village, to see concessions, and to other places where he thought the gold appeared to be valuable.

As soon as possible we started. The ordinary African delays, of course, occurred. We had the number of carriers counted, for which purpose they were mustered before our door in the evening. At six o'clock in the morning, when we wanted to start, we had to go through the muster again, and find out who was absent. However, there was good-will amongst the people, and we got on. We then moved off from Axim, passing, first of all, above some dwarf cliffs of red clay, much like those I have seen on the Tanganyika. When I was on the Tanganyika, I was not thinking much of the gold; I was thinking more about getting through the country. Now, from what I have seen on the West Coast, I am perfectly certain that on the Tanganyika, and in the Rubeho Mountains, besides in Katanga, whence I saw gold brought, the precious metal may be found.

Leaving the undulating ground, we went for a short way along the sea-beach, and then, passing behind the hill which forms Akrumasi point, we came to the banks of the Ancobra river inside its bar. On Akrumasi point once stood the fort Elise Cartago, which shares with another the honour of the following story. It was attacked by the natives, on account of the quantity of gold stored. All the lead being expended, bullets of gold were fired, and at last the Dutch commandant, finding almost all his powder was gone, and that every chance of keeping out his assailants was lost, opened the gates and admitted them to the fort. But there was somebody down in the magazine underneath the level of the palaver room; when the natives arrived, the commandant tapped his foot on the floor, and he and everyone were blown up immediately. Sooner than disgrace his colours by allowing them to fall into the enemy's hands, he sacrified his own life, and the lives of his assailants. We crossed the Ancobra river, and then we came into the district usually called Appolonia, which reaches from the Ancobra river to the French frontier at Assini. The first district extends to Behin, and each village might almost be considered a separate tribe, with slight differences of dialect. At Atabu, which is the chief settlement of King Blay, we met King Blay, and instead of being dressed in the general officer's cocked hat, he was in his fetish dress. He had a sort of cloak covered with bells and *gri-gris*, and had on a hat, shaped like a paper cocked hat, adorned in like manner. The next place westward of that was Behin, which was in ancient days a strong fort. The places I am speaking about are nearly on the fifth parallel of latitude, from 4°48′ to 4°56′. Behin was once an old English fort, and we there found traces of the bombardment by an English gunboat during the Ashanti war, when the people of the place had fought against King Blay.

[Capt. Cameron here described on the black board the situation of the Tandu lake, the Tandu river, the Assini river, Newtown, Appolonia, Behin, and Atabu, the Ancobra river, and a number of other villages in the great gold-mining districts, up to Axim.]

Behind Behin there is a sort of swamp, and from it runs Ebumesu, or winding water, which goes into the sea half way between Atabu and Behin. We found all along the sands the black sand out of which nearly every gold miner knows gold is to be obtained. Where gold is found in this case, it is principally in titaniferous iron, and all along the sea-beach we found the gold-bearing sand. I have, myself, seen a woman, in two hours, wash out 3s. 6d. worth of gold. Working from 8 to 10 hours, they would be very dissatisfied if they did not make from 4s. to 5s., though I have known them to make as much as 22s. in the course of the day. That is not done all the year round, but only when the freshes come down. Immediately behind this line of present lagoons we come to the commencement of the hills, which in nearly every case run between North 4° East, and North 22° East. Out of the whole of the hills which I noticed, I only found one throwback where the lode had been disturbed; they run parallel to each other, and are islands of a great archipelago. Mangrove trees grow far away from sea, and have warped up many of the valleys above sea level; in some cases this action is still going on. A slight upheaval has also taken place. Still, even now, often close to the sea, there is no solid land in the hills, but only mangrove swamps. In these valleys, I believe there will soon be found one of the greatest sources of our riches, and the cheapest way to work will be some mechanical means, to raise the soil in the bottom of the valleys, and the same machinery that will do this, will pump the water up that will wash it down; not, as is done in Australia, by bringing water from 50 to 60 miles, and giving it a fall, but by raising it by means of machine-power, and so washing down the side of the hill containing the gold. From Atabu we went to Izrah where we found, gold reefs, and then we crossed two or three streams showing gold, and worked down to the mouth of the Ebumesu, and then returned to Axim, finding all the way along gold formations. Upon the table there are some bags which I have not yet opened, but I believe in each of them will be found gold, but of the plaster that is used for the walls of the houses of the place, I have myself, though I am not a good washer, taken from a couple of pounds a good show of gold. Then, from the Axim we went by the surf boat to Prince's river, near the mouth of which is the old fort Brandenburg. Going up the river, we found it wound enormously, and after eight hours' work, we were about two and a-half miles from the coast; and here, again, the same thing occurred, a number of small islands, with the valleys between, warped up by mangroves, every one of them containing reefs. We went up the river some distance above the lagoon till we came to a place called Kumasi—not the Ashanti Kumasi. Here we found reefs lying parallel to the river through a valley between them, and we found that the river was running in such a way that it was very easy to put dams on the cross reefs, and at once to take the surface washings of the hills off; out of these surface washings we got good results, as well as out of the quartz, which was obtained by digging, and also from the boulders that rolled down the hill side. Returning to Axim, we went up the Ancobra river, and visited the Ingotru mines. These mines are enormously rich, but I am afraid the place will be found a very uncomfortable one to work. Besides Ingotru, I passed a hill in which I had heard a friend of mine had some interest, and I thought I would stop the boat and go ashore, in order to obtain some of the swish, as they call it—that is mud—off the hill. I got a woman to wash some of this mud afterwards, as they seem to do it more skilfully than others; but, unluckily, in my hurry on leaving Liverpool, I have left the test-tube behind, in which the results were put. I may say that there was some gold in it. Next, still ascending the Ancobra river, we passed an old mine on the left bank of the river at St. John's, which was worked by the Dutch and Portuguese, and, after visiting the Akankoo (Akankun) mines, we advanced up the river to Tumentu. At this place the great misfortune of our journey occurred. Captain Burton and myself thought we were old travellers; and though we have often advised others not to do too much, we tried to do too much ourselves. Having been twelve hours in a launch trying to get the bearings of the river, I sat up four hours one night in a dew, to take sights, in order to check my dead reckonings, and naturally, through this foolishness, I was stricken down. Captain Burton caught the fever at the same time as myself. We both had to go down to Axim again, and Captain Burton being an older man, did not recover so readily as I did, and it was not wise for him to go on. He hoped to be able to make a voyage down the coast, but that was found impossible. I went back again; I went up the Ancobra river to the farthest point of navigation, for it would not be practicable to make any use of the river beyond the Butabué Falls. I visited the Isiamankao concession, and besides examining the reef there, I found in the flats, at a depth of 6 or 8 feet, what had evidently been a lagoon deposit, and in some places at a depth of 8 feet, varying according to the undulations of the surface. This deposit was a couple of feet or more thick, and appeared to be good gold-bearing ground. The upper part had traces of gold in it. Coming back from Butabué Falls I returned to Tumentu, which is one of the points where the navigation of the river ceases for some companies. Going across the country, after leaving Tumentu, I made my way to the Abunsa River, and crossed at a point where several companies have depôts. All the way I found the hills running in the same direction, and there I found quartz and talcose gneiss, and I also found blue quartz similar to that of the Akankoo mine, which contained four ounces of gold to the ton. After the Abunsa River we camped the first night on the Tebribi hills, and then we went to the Takwa range. The first mine I visited here, the Effuenta, has machinery erected, but, unfortunately, the pumping power only gives enough water for six heads, though they have twelve erected. At the present time, with their staff, and the means at their command, they may crush ten tons a day, but this they will be able soon to increase. They can now, with enough men, bring 100 tons to bank daily. The other mines are the Takwa (not working), the African Gold Coast, the Gold Coast, and the Mines d'Or d'Abosu; and here I may remind you that I am not interested in any one of these mines; I have nothing at all to do with them, I simply visited them, and am now trying to tell you honestly what the facts are. One throwback of the formation happens in La Mine d'Or d'Abosu, one of the French companies. In these gold fields, Messrs. Swanzy have done most gallant work; they have erected machinery with great difficulty, and have made roads in order to transport the machinery, though, I am sorry to say, this has not been done to the same extent by other persons. I have since learnt that some of the companies helped to pay for the work. Here is some of the quartz which has been taken out of Crocker's reef, and I dare say many of you who see gold in quartz in this way, would say that is the best of all; but when I see gold in a string like that in white quartz, although it may continue for some time like that I do not think it is likely to last. Here is another specimen; and this is the kind of thing sometimes shown to people to make them invest their money; but that is not the gold reef which I should work if I was mining. All these mines have works varying in extent, the oldest established being the African Gold Coast, which is half English and half French. Many questions have been raised as to the machinery employed, and I may say that the machinery in use in some has not been tested in another country, so that money has been lost, though, at the same time, the experience gained will accrue to the advantage of those who succeed the present workers. The people who honestly try these things deserve praise, even if they make mistakes. [A sketch was here drawn upon the black board, showing the position of the different reefs.] There is a certain amount of covering-soil on the hill, but the gold-bearing stuff has been worked a little, though the natives have not been able to work it all, owing to their not having the proper knowledge or appliances. In fact, the native workings are useful as indications of rich spots. The great bugbear to contend against is the climate. When all these questions of drainage and swamp have been cleared away, and the overpowering mass of vegetation, we shall be able to do something in this country. People talk of primæval and impenetrable forests; I have seen on some of the older hills certain hardwood trees of a certain size, and cotton trees of great growth, but the main portion is comparatively scrub, and small trees which have grown within the last 100 or 200 years, since the Dutch were working or in the country.

The Dutch have never told us the whole truth of how they worked, and what amount of gold they got out of it; although they spoke of very much, they did not tell us the exact amount. In working, the natives have found that they have been able to drive on the footwall of the lode, and there are the most extraordinary places to be seen, where they have driven 80 or 100 feet in. I should be sorry to try and scramble down these places; but the natives do, and have dug out gold with their little iron chisels. Sometimes at the side of the hill, there would be a series of ten shafts, in which men work very much like chimney sweeps, and these shafts were entirely unsupported, and in alluvial soil. The natives do not like hard work or danger, so that it is quite plain that they must have been richly paid for their trouble in getting the gold from these shafts. We have brought some quartz from the country further back which we did not visit, from which it will be seen that, when we work into the interior, we shall no doubt find some of these nuggetty mines, and stir up the British population by turning up nuggets of 3 or 4 ounces, or even as large as the footstool of the King of Gy'aman, which weighs 32 pounds. Here are some nuggets which I have brought with me. The footstool of the King of Gy'aman, to which I have referred, has to be carried upon the shoulders of two men, suspended from a pole.

Hitherto, I have told you what we have seen, but now I will tell you what I think has to be done. We found, as the grandfather of Mr Swanzy stated, in 1816, when examined before the Committee of the House of Commons, that the whole country was impregnated with gold. Messrs. Swanzy are one of the oldest firms in the country, and on the question of modern gold mining they are amongst the first authorities. In order to develop gold mining, we shall have to obtain good machinery, and also seriously to face the big question of labour. At present it is not very difficult to find labour, but if we have taken the trouble to note the number of Krooboys employed upon the coast, in the steamers, in the oil rivers, and in the mines, we found that there has been an appreciable rise in the rate of their wages since working in the mines has commenced, so that I do not think, when the mines are properly opened, we can trust to Krooboy labour, or even to the Fantis, because the latter are beginning to find out that they can use powder, and that they can make more money for themselves than by working for wages. At one time, the country was ten times more thickly populated than it is now, and the French, who lead us in most things in Africa, show us what should be done. Last December, 137 Chinese coolies were brought by the French to carry out some experimental works, and during the five months they were working, not one of these men had died, as far I as have heard. If we can get a persevering race like that to do the work, the labour question will be solved; and now, when we see Chinese rice being imported into Africa, I cannot help thinking that the question of labour has begun to be solved. This is not my own idea, but I have thought it carefully over for some time, and I am convinced that the labour question will be a crucial test; though I believe it can be easily overcome if our Government will give consideration to a well-considered scheme for placing Chinese labourers in our settlements. If a person were able to obtain Chinese labourers, he could afford to pay them higher wages, because he would know he could depend upon an industrious race of people, and that he would be able to place his works upon a better footing. The people of Wasa are a most pleasant and civil race; they do not agree with our idea, perhaps, of the part we took in the Ashanti war, but they are a pleasant class to deal with. Many of the arms, and much of the powder used, is imported from the French settlement of Asini, where any ship might land stores without any restriction whatever. There is no doubt that, during the Ashanti scare, there was a certain amount of smuggling of arms across the frontier, which shows that these people are not perfectly safe.

There are many other things which we did, that I cannot explain to you to-night, as it would take some considerable time; but I may say this, that Captain Burton and myself have made a large collection in natural history and botany. I have brought home many different kinds of butterflies, and different kinds of stone implements. In the specimens of quartz on the table, you will notice the difference in formation. In this I found two coloured crystals, and though I was not able to measure the angles, not having a goniometer, I am persuaded that we may find garnets and rubies. There was one piece found in some washings which was reported to be a diamond, and was said to scratch glass; but I did not see it myself. There is so much hard crystal that has not got the right number of sides, or the right number of angles, though it will cut glass, that one cannot be sure of this; and as I did not see it, I cannot say much about it, but I have a strong idea precious stones will be found. If you look at the end of one of these pieces of quartz, you will see how strait the cleft has gone. I have seen pieces from a similar lode that have come out exactly as if they had been formed in a mould. It is a conglomerate, and the pebbles have broken through in the blasting as straight as if they had been cut with a knife.

In conclusion, I can only say I hope the mines of Africa may have a large success, and that everybody connected with them may work harmoniously together. I thank you for the very kind way in which you have listened to this very imperfect story.

DISCUSSION.

The CHAIRMAN said they were much indebted to Captain Cameron for his very interesting description of his visit to the West Coast of Africa, especially as he had been taken by surprise, in consequence of Captain Burton's illness, and had only arrived in England, he believed, on Saturday. It was remarkable that, as he had mentioned, throughout the whole of Africa there was that tendency in the native mind to trade; it was a very fortunate circumstance, in one respect, because it showed that when advancing civilisation had made an entrance, we should be met in a friendly spirit by the native traders, who would desire to exchange their goods for the luxuries of civilisation. The fact that they themselves were alive to the value of gold was another encouraging feature. It appeared that they were in the habit of washing the black sand, and gaining thereby on an average 3s. 6d. to 4s. a day, the amount sometimes reaching as much as 22s. by some fortunate find. He took it they were hardly yet able to manipulate the quartz, because that required machinery, which entailed a considerable amount of capital; but he had no doubt that in time machinery would be introduced, and that its introduction would be beneficial in every way. With regard to the climatic influences, Captain Cameron did not appear to think that much good could be done until the lagoons were drained; but he feared some difficulty would be found in doing this easily and economically. If such an undertaking could be accomplished, it would do more than anything else to open up Africa, because it would make it comparatively healthy. It was a curious fact, that the Chinese were able to reside in that country, and cultivate it; but the question of the introduction of Chinese labour was rather too large a one to enter upon on that occasion.

Surgeon-Major Dr. HORTON said he had spent many years on the Gold Coast, and had taken great interest in gold mining Being an African, and loving his country, he hailed every means which could be used to develop and civilise it, and he felt that gold mining would be one of the best means for uplifting the country from its present degradation. For himself, he owed a great deal to the British nation, and he could assure them that the Africans loved England, and the people of England, and were always ready at any time to promote anything which England brought forward. There were other colonies on the Gold Coast besides the English, but in the British possessions you found a greater advance in civilisation, education had taken a far firmer hold of the people, who were more religiously inclined. He could assure them that in the Gold Coast there was a new California, though this would only appear when it was further developed. With regard to women washing gold at the rate of 4s. 6d. to £1 1s. a day, he knew a place at Cape Coast, where, after a heavy rain, you would find 100 to 150 women washing, and he knew of an instance where a woman, in a day and a-half, realised £7 4s. This was sufficient to prove the truth of Captain Cameron's theory, that the washings from the hills, and the deposits in the valleys, would be found some of the richest deposits, and could be worked by any company. The first and pioneer company on the Gold Coast, was the African Gold Coast Company; that Company did its work well, but, unfortunately, they had not had machinery which would bring good dividends to the shareholders. Experiments had been made, and proper machinery had now been discovered which would enable future companies to pay their shareholders very well. The next company was the Effuentah, whose works were situated on the south side of the range. He had been there himself. They had four different places, and shafts in another place, and it was only the want of proper machinery to raise the water from the valley up to where the stamping machinery was, which prevented their paying large dividends. Next came the Swanzy Company, whose agent, a very hardworking, indefatigable man, had opened up the country a great deal. They opened their mines first at a quartz reef, and found some pockets with a large quantity of gold, but unfortunately, it was only a pocket, and having worked for a long while, they were unable to find another. But on the other side of their concession, there was a very rich sedimentary stratum, from which they were able to get from 2 oz. to 3oz. per ton. Mr. Crocker, their agent, was working very hard to develop the property, and to prove that from Africa they would be able to send an amount of gold equal to what California sent in former years. Next came the Gold Coast Mining Company, which commenced with a very small capital, but Mr. Creswick, the manager, had so developed its mines, that it stood almost above the others, because the amount of gold in the quartz reef ranged nearly £4 to the ton. The French Company came next, and afterwards the Takwa Company, and one or two others. The question would be asked, why they had not paid dividends, but the fact was, that most of them had only been formed within the last two years, and there was a great deal of preliminary work to be done; the bush had to be cut down, and roads made, before they could open the mines, and it was not until they got the quartz that they sent to England for the machinery, so that it took a long time before they were able to make returns. But the new companies would learn by the experience of the older ones, and it was to be hoped that returns would soon be coming forward which would show the public that in the British settlements in Africa there was a new California. The question of labour was very important; he believed, that all along the West Coast, the Kroomen would be found most valuable. They came from their own country down to the coast, and entered into an agreement for about a year, and then returned home, and each man got himself a wife. In many cases he stayed at home until he had spent all his money, and then went back again, taking some of his friends with him, and entered into another agreement, generally for a year or 18 months, at the outside. The Kroo country was very large, occupying 600 to 700 miles of the coast line, and teeming with population. The people were known to be very good workmen if treated well; and they were especially fond of the English. Most of them had worked in her Majesty's ships, for every vessel that went out employed several of them, and they were good sailors. They were also very useful in the mines. Wherever they were well treated, you could get any amount of work from them. The next question was the climate; and having served nearly 24 years as a medical officer in her Majesty's service, all over the coast, from the Gambia, right down to Lagos, he was able to say that, as years passed on, and the cultivation of the land improved, they might expect to find better conditions in that respect. There was no doubt the climate was bad for Europeans; but, unfortunately, many men went out there, and not considering they were going to a strange climate, exposed themselves to evils which aggravated its bad effects. Very many of them kept late hours, and having to rise early, to attend to their duties, they found, after a little while, that their constitution gave way, and then the climate had to bear all the blame. But you found men who retained their health very well, by keeping early hours, taking good food, and being careful of themselves. He did not recommend teetotalism, but moderation. Some men had been there 36 years, some 50, and he knew one who had been there 60 years, who, visiting England, and not being used to its climate, unfortunately died.

Mr. J. G. LOVELL said he endorsed everything about the richness of the African gold; indeed, everyone who had visited the country, or read about it, knew that it was probably the richest country known in gold; but this address, being delivered by so eminent a man, would be published in all the papers, and he was afraid it would go forth that you had only to go to the West Coast of Africa, and pick up gold on the beach. He wished to guard against people being led away by any such misapprehension.

Surgeon-General GORDON, C.B., said he had served on the coast of Guinea, in 1847-8, and though, no doubt, many of the circumstances had changed since then for the better, still there were many which had not changed. He took it the latitude of the coast had not changed, nor the climate, to any material extent; and, consequently, the remarks which were applicable in 1847, were, more or less, applicable now. He would remark, in the first place, that at the time when he served there, the advertisements of insurance offices used to state that lives were insured for all parts of the world, the West Coast of Africa alone excepted. During the time he was there, out of 34 white men on 200 miles of coast, 16 died. Of six white men who got up an expedition, in 1847, to go to Appolonia, he was the only survivor. Much was said about the recklessness of men in tropical climates, in order to account for the mortality, but he had served in as many bad parts of the world as most men, and he was sure there was as much absence of excess amongst the officers on the West Coast, as anywhere; and, as far as his recollection went, there was less drunkenness. To show how little the manner of life affected the question, he might mention one circumstance. Amongst four persons who were there at one time, he, himself, being one of the four, two were remarkable for their habits; one, to use a common expression, seldom went to bed sober, and the other never drank anything but the weakest claret and water. One of them died in one day less than a month, and the other in one day over the month. That showed that, over and above personal habits, there was that in the climate which no white men could stand until he had gone through the "seasoning." When he was out there, there were a large number of missionaries, and it was a most painful thing to see the young men who came out, walking up and down, day after day, waiting for their seasoning, which meant an attack of climatic fever; because it was found quite useless to send them to a station inland until they had undergone it. He recollected perfectly well that the statistics of their recoveries was about 1 in 3. Once a European had undergone a seasoning, so long as he remained on the coast, his health was as secure as anywhere else. With regard to the question of gold, he held in his hands some notes, which he wrote in *Colburn's Magazine*, in September, 1850, from information personally obtained, some of which he would beg leave to read. [One quotation read was to the effect that tenpence a day was considered very remunerative for gold-washing; and another referred to the Dutch mines at Elmina, and stated that great mortality prevailed amongst Dutch miners who had gone out there.]

Mr. SHIPPEY said he had a brother who had been resident for some time 170 miles north of Timbuctoo, and from information he had derived from him, the scheme put forward by M. Lesseps, to flood the Desert on that side, would do an immense amount of harm to those in that part of Central Africa. He might also say that he had in his possession abundant evidence to show that there was a great deal of gold in that part of the country, and, in fact, on the borders of the Desert of Sahara there was lying an unlimited quantity of gold, which only required to be picked up. The leading chiefs in the neighbourhood were anxiously waiting for England to help them to develop the riches of the country. Only six weeks ago, he had brought this matter before a firm of bankers in the City, and left his papers with them. Unfortunately, they had been mislaid; but he intended to bring the matter before the Geographical Society

Mr. MACARTHY said, after having been two years on the West Coast, most of the time in a tent, he might be able to say a few words on the climate. Undoubtedly what Surgeon-Major Gordon said was true with regard to Government officials—the Government did not take care of the men sent out there; but amongst the mining colonists, the per-centage of ill health had been nothing like that amongst the Government officials. That the Government could take care of the men was proved in the Ashantee war, when the death rate, as shown by Lord Carnarvon, was only 23 per thousand—equal to the rate of mortality in a healthy town of England. He had been where a commandant was placed in a fort alone, without a medical officer, without any furniture in the place, and without any means of getting food for himself; how could men be expected to live under such circumstances? With regard to the riches of the country, he fully confirmed Captain Cameron's account. The country was overlaid with gold-bearing drift, and not only that, but you got, generally speaking, a clay slate, with dykes of granite underneath; the natives had worked from time immemorial on that coast; their works proved what they got, and the returns for the coast annually sent home were fully sufficient to prove the amount of gold which could be procured, even by their crude means. Their method of working quartz was very crude, not that they could not mine; they knew all about the rudimentary system such as we had before gunpowder was introduced, and could go through the hardest rock, but what they objected to was the grinding of the material.

Mr. WALKER said that having recently returned from a six months' tour on the Gold Coast, and visited nearly every one of the mines, he thought he was competent to speak as to the richness of the country, but he would confine himself to the question of climate. He stood there, having passed upwards of 31 years on the West Coast. Out of that time he had spent some months less than six years in Europe, and he was as healthy as any man in the room. He could point to other gentlemen present who had spent long periods on the coast, and who were as healthy as any one. He once spent ten years there without returning to England, and another time five years. Any person with a good sound constitution, who went to the West Coast, no matter what part, from Goree down to Cabenda, and who took care of himself, need fear nothing, especially if he worked hard. Those who worked hard did not die. The most unhealthy men were the officers of the West India regiments, because they had nothing to do. There was an old saying there that the people who went to the West Coast must be put into three categories—the temperate man, the hard drinking man, and the teetotaller; the temperate man lived the longest, the hard drinking man had the second chance, and the teetotaller died first.

Mr. MARTIN WOOD asked what was the greatest depth below the average surface of the country to which these gold investigations had penetrated. He need not say that they were sufficiently *blasé* with accounts of this visible gold, but the question was to know from some competent scientific man how far down would the permanent deposit of gold be found.

The CHAIRMAN then moved a vote of thanks to Captain Cameron, which was carried unanimously.

Captain CAMERON, in reply, after thanking the meeting for the cordial reception he had received, said, with regard to the last question asked, he could only say that the natives, having no pumps, were blocked out by water; but as far as they had been able to go, they had found gold. One could only judge, to a certain extent, by the dip and line of the hills, how far the different bed rocks ran. It was impossible to answer such a question until there was more material taken out, except in a theoretical way, and he did not wish to commit himself to any statement of that kind, until he had worked it out under the advice of some English geologist; but he had made some careful observations, and hoped he might soon be able to give a theoretical answer to the question. He had listened with great interest to what Dr. Gordon said, but he would remind them that that gentleman was speaking of 1847, and he of 1827, when Admiral Beaufort was at the head of the surveying service, and when they were losing boat's crew after boat's crew, right along the coast, because the naval officers persisted in bleeding. Later, they insisted on enormous doses of calomel, and until a very recent period, on enormous doses of quinine. He did not profess to be a medical man, but with Warberg's tincture, and arseniate of quinine, he could reduce any fever. It had always been successful with himself, and also amongst men he had had to treat, for amongst the natives of Africa there were, perhaps, as bad fevers as amongst Europeans, if they changed their climate, and went from one part to another. When he first knew Zanzibar, in 1866, it was supposed to be most unhealthy, and there was a standing order that nobody should be allowed to stop on shore. His friend, Sir John Kirk, went there in 1865, married in 1866, and most of his married life was spent there. Two children had been sent home, and when he saw the family last year they were as healthy as possible. That was a place where, in 1857, in station orders, it was unsafe for a white man to sleep on shore; but now they had their polo parties and croquet parties, and everything else. They learned to live in these places, and progressed with experience. The West Coast had never been thoroughly studied yet; Dr. Horton, Dr. Gordon, and others, had studied it no doubt; but it was a combination of a large amount of experience which was wanted; as Mr. Walker said, hard work was the thing. You might over-do it, of course, but plenty of work was the best way to keep off disease.

TWENTY-FOURTH ORDINARY MEETING.

Wednesday, May 31st, 1882; Sir RUTHERFORD ALCOCK, K.C.B., in the chair.

The following Candidates were proposed for election as Members of the Society :—

Bohn, Henry, 142, Holland-road, Kensington, W.
Bryan, William Booth, Woodfield, Blackburn.
Chance, Alexander M., Alkali Works, near Birmingham.
Freakley, William, 41, Pyenest-street, Shelton, Staffordshire.
Higgin, George, Broadway-chambers, Westminster, S.W.
Humphrys, James, Anglo-American Brush Light Corporation, Limited, Belvedere-rd., Lambeth, S.E.
Kinipple, Walter Robert, 2, Westminster-chambers, S.W., and Whitefarland, Greenock, N.B.
Shore, Lieut. the Hon. Henry N., R.N., Coastguard, Greenock, N.B.

The following candidates were balloted for and duly elected members of the Society :—

Beckingham, James Horace, 48, Percy-park, Tynemouth.
Bright, Thomas Smith, Glannant, Carmarthen.
Buchanan, John, 4, Windsor-crescent, Newcastle-on-Tyne.
Cooper, Henry, 20, Moor-street, Soho-square, W.
Morris, William, 2, Westminster-chambers, S.W., and Greenock.
Searchfield, Charles, Merchants' College, Claremont-park, Blackpool.
Wells, Rev. Edward, B.A., Flamstead Vicarage, Dunstable, Bedfordshire.

The paper read was—

GOLD ON THE GOLD COAST.

BY CAPTAIN RICHARD F. BURTON.

The glory of an explorer, I need hardly say, results not so much from the extent, or even from the marvels, of his explorations, as from the consequences to which they lead. Judged by this test, both Captain Cameron and I have been not unfavoured of fortune. At Bihé, the province through which my friend and companion painfully hurried, a practical mission is now established; American missionaries bring consuls, and consuls bring commerce and civilisation. In Unyamwezi, where two purblind, fever-stricken men plodded amid the fetid swamp and fiery thorn bush, over the Zanzibar-Tanganyika track, mission houses and schools may now be numbered by the dozen. On the Gold Coast of Western Africa, whence came the good old "guinea," there has been a change which will form the subject of this evening's paper.

The following extract from "Wanderings in West Africa," a book which I published in 1863, will best explain the reasons that sent me once more to the unfortunate and ill-famed coast.

> "In several countries, such as Denkira, Tueful, Wásá (Wassaw), and especially Akim, the hill-region lying north of Accra, the people are still active in digging gold. The pits, varying from two to three feet in diameter, and from twelve to fifty deep, (eighty feet is the extreme), are often so near the roads, that loss of life has been the result. 'Shoring-up' being little known, the miners are not unfrequently buried alive. The stuff is drawn up by ropes in clay pots, or calabashes, and thus a workman at the bottom widens the pit to a pyriform shape: tunnelling, however, is unknown. The excavated earth is carried down to be washed. Besides sinking these holes, the natives pan in the beds of rivers, and in places collect quartz, which is roughly pounded."

"They (the Fantis) often refuse to dig deeper than the chin, for fear of the earth 'caving in;' and, quartz-crushing and the use of quicksilver being unknown, they will not wash unless gold 'show colour' to the naked eye."

"As we advance northwards, from the Gold Coast, the yield becomes richer. . . . ."

"It is becoming evident that Africa will one day equal half-a-dozen Californias. . . . ."

"Will our grandsons believe in these times . . . . that our Ophir, that our California, where every river is a Tmolus and a Pactolus, every hillock is a gold field, does not contain a cradle, a puddling machine, a quartz-crusher, a pound of mercury? That half the washings are wasted because quicksilver is unknown? That whilst convict labour is attainable, not a Company has been formed, not a surveyor has been sent out? I exclaim, with Dominie Sampson—'Pro-di-gious!'

"Western Africa was the first field that supplied the precious metal to Europe. The French claim to have imported it from Elmina as early as A.D. 1382. In 1442, Gonçales Baldeza returned from his second voyage to the regions about Bojador, bringing with him the first gold. Presently a company was formed for the purpose of carrying on the gold trade between Portugal and Africa. Its leading men were the mariners Lanzarote and Gilianez, and Prince Henry "the navigator" did not disdain to become a member. In 1471, Joao de Santarem and Pedro Escobar reached a place on the Gold Coast, to which, from the abundance of gold there found, they gave the name Sao Jorje da Mina, the present Elmina. After this a flood of gold poured into the lap of Europe; and at last, cupidity having mastered terror of the Papal Bull, which assigned to Portugal the exclusive right to the Eastern hemisphere, English, French, and Dutch adventurers hastened to share the spoils."

After this much of preamble, I at once plunge in *medias res*. My chief care must be, not to repeat the short but comprehensive account of our visit offered to you a few nights ago by my friend, Captain Cameron, of African fame, the best traveller, and the most genial companion of travel as yet known to me. We landed at Axim, on January 25th, 1882, instead of September 25th. The delay was at once inevitable and fatal to the feat of exploration, a visit to the quasi-mythical "Kong Mountains," which we proposed for ourselves. The Harmatan, or cool season, had closed, and an exceptionally hot and unhealthy summer was setting in, promising early and heavy rains.

Axim, the principal port of the Wásá province, and the chief exportation-place of the future gold mines, lies on the western third of the Guinea Coast. Here the mighty bulge of the ham-shaped continent bends from north-south to a western-eastern direction, the lay being between four and five degrees north of the equator. Of its climate I shall have something to say presently.

Axim, as far as nature made her, appears to the stranger an exceptionally pretty place. The bay proper is bounded north and south by two green points, Bosumatto and Prépré. The tints are the true African tricolor—faint blue, vivid leek-green, and brick-dust red. The forms of the landscape are less easily described. The horizon line is a wavy wall of giant trees, often 150 feet high, and palisaded with white trunks bare of branches. The "bush" is inferior only to that of Australia. The flat ledge upon which the town, or rather village, reposes, is dotted with luxuriant growth, and the sea is gridironed with lines of weather-blackened trap or greenstone (diorite), projecting perpendicularly from the shore. Under cover of these reefs, landing is safe.

The only striking object of the settlement itself, is the Fort Saint Anthony, which was, as usual hereabouts, built by the Portuguese, taken by the Dutch, and finally annexed by the English. Its site is a wart of ironstone, thinly greened over with wild growth. The building is a large square house, mounted upon bastions, which bear old-fashioned cannon; a cavalier imperfectly commands the sea-approach, and two batteries the landing-places. Carefully whitewashed, it is a conspicuous landmark. The townlet extends in two patches, to the north and south of its protector. The long streets, avenued with shady fig trees, are well laid out; the tenements are mostly native houses, built of bamboo-fronds *(Raphia vinifera)* with thatch supplied by the leaf of the same palm. Europeans affect whitewashed abodes, with swish walls. The various mining companies here have their quarters, as the "Akankon House," the "Gold Coast," the "Effuenta," and the French factory, near a foul swamp. There are two commercial establishments, Swanzy's, and Lintott and Spink's, whose agents are lodged in a superior way.

Much is evidently to be done at Axim. Landing under cover of the two islets is easy throughout the year, except on the rare occasions when the surf is urged by stormy winds. But a landing-place is wanted, so is a hôtel, a station with a tramway, and a host of other civilised requisites. They will come in time. *Festina lentè* is the motto for Africa.

We are now in the Land of Gold. After rains, the women wash and pan the black sand (titaniferous iron) of the foreshore; and make from half-a-dollar to two dollars a-day. Dollars, therefore, are cheap, while women are dear. We have found gold specks and spangles by treating the swish of which the rude walls are built. "Colour," as they call it, appears in the red soil of the very streets. A few yards behind the town a quartz-reef runs north and south, easting rather than westing, the usual meridional lay in these lands. By crushing specimens, we obtained a yield of two ounces per ton; in fact, superficial gold everywhere abounds, and in this particular I found the coast richer than California in 1859.

At Axim, we were fortunate enough to collect sundry specimens of worked stones, the first brought from this section of the coast. The place appears to have been a great centre of lithic manufacture; huge boulders lie about the fort, and elsewhere, with grooves three feet long, in which the implements were ground.

After a week's preparation, we left Axim, to visit sundry concessions for proposed mines. There being no horses hereabout, the hammock is the universal conveyance. Originally it was used only for the beach; never for the "bush." Hence it is carried by two pair abreast, a cross-piece at right angles, and a bamboo pole resting upon the head. Nothing can be more unpleasant than its jolting, stumbling, wriggling motion, which dizzies the brain, and makes every limb ache as with rheumatism.

We first visited what I shall call the "Axim Reef." The path leads, for a quarter of an hour, off the main road, to the Ancobra River, up a little fiwmara, which flows only after rain. The people have dug in the bed and the bedside what are here called "women's washings," that is, shallow pits to extract the metal; and the men have sunk a chimney-hole to the quartz-reef, which, at a higher level, subtends the stream-bank. The site is in a deep forest, and for square miles to the north and east, the ground has been bought by English adventurers for future treatment.

A few hundred yards north of the town, at a hamlet, elegantly termed by the Anglo-African, "Stink-fish" (*i.e.* sun-dried fish) town, begins the great Apatim concession, belonging to a well-known English merchant, Mr. James Irvine, of Liverpool. Here we first noted how easy and how profitable it will be to "hydraulic," that is, to wash the whole land, after Californian fashion. We then crossed the Ancobra River, the great "snakey" artery of this region, and inspected the "Izrah Mine," for which a company has just been formed. The site is open, healthy, and pleasant, four miles from the coast, within reach of the sea-breeze, and within hearing of the Atlantic surf. At the southern extremity, the natives have sunk shafts by the dozen, but have neglected to wash the superficial deposits. Mining prospered in the days of slavery, when a man could bring gangs of hundreds into the field. We shall substitute the machine, the cradle, the long-tom, the sluice, Norton's tubes, and the force-pump. Our trip ended with inspecting the Inyoko concession, another admirable ground for the hydraulic working of gold,

After a short delay at head-quarters, we set out in a surf-boat eastward, or down coast, to prospect the mines of Prince's, *alias* St. John's River. The landing was peculiarly unpleasant. You must choose the proper moment, and force your boat through the triple line of breakers which guards the strand; this done, you unload her, carry the cargo over the sand-strip to the safe and quiet inner waters, and warp the craft round the jaw of the river's mouth. A fearful rock-studded bar prevents your entering the latter, which at this season is not too broad for an English hunter to clear at a leap. Inside, the lower river-bed widens, as is here the general formation, into a "broad," or briny lagoon, rich in the finest oysters, growing on the rocks, as well as on the mangrove stems. Nothing can be more marked than the winding of the bed; and, after hours of paddling, you are still close to the shore. We shot for specimens when paddling up-stream, and brought back sundry spoils—black swallows, and charming little kingfishers of dark robe shot with green. Canoeing down, we carried of gleanings of botany from the banks. The vegetation is marvellous, and the collector is ever haunted by the idea that he wants months to do justice to a single square mile. Nor is the task altogether pleasant. Snakes haunt the trees, making the Kru canoe-men mad with fear. The bush has spines like the fabled Arab Zakkum, the thorn-tree of the Inferno. Wild bees and wasps at times swarm; and every bright flower is tenanted by some species of ant more or less vicious and venomous.

After two days' short work, we reached the terminus of river navigation, landed, housed our goods at a country Kru (village), and walked north to the proposed mines. That adjoining the Kumasi village, near the right bank of Prince's River, will supply a quantity of a valuable wash dirt. Its *vis-à-vis*, on the other bank, christened by us São João do Principe, is equally promising.

Returning to the river-mouth, we visited Prince Town, which the natives call Prinsi Ollandia. Yet the fort which adjoins and defends it bears in some old books the Brandenburgh flag. Despite threats of deadly snakes, we visited the ruins, and found them delightfully situated upon a breezy hillock, commanding a glorious view, and the walls are so solid that a little repair will make them good as new; and here, in imagination, we placed a sanitarium and hospital, a huge store, and eventually baracoons, for Coolie immigrants. The old factors and traders on this coast certainly knew how to live in comfort, despite the climate.

Our next and my last visit was to the Ancobra River, which we ascended as far as the highest point surf-boats can reach. The marvellous vegetation is that of Prince's; the birds and monkeys are more numerous, and the meanderings of the bed are preposterous. Most of the river-frontage has already been secured by companies or individuals; and no wonder. Here and there you see women washing the dirt of the banks for gold. This, too, is nature's highway to the mines lying north and north-eastward of the river-head; and so it will remain till tramways are laid down.

We spent a day prospecting the Ingotro concession on the right bank. The soil is immensely rich, and the people have shown, by extensive washing, the proper way to work its wealth.

From Ingotro we ran up the right bank to the Akankon concession. Here the southern creek extends to a hill-side pitted with "women's washings;" and a few wooden sluices, a force-pump, and a "crinoline hose," will, for the present, prove far more useful than stamps and steam-engines. Briefly, the Akankon is the richest ground we have hitherto seen.

We remained four days at the Akankon concession, and suffered severely in the flesh, both of us at the same time. Cameron was prostrated by a bad bilious attack, I by the normal African ague and fever. He treated it with chlorodyne, I with Warburg's Drops (*Tinctura Warburgii*), an invaluable preparation which no "African" should forget. We managed to reach Tumentu, the terminus of river navigation, and the "Great Central Depôt" of the mines, a beggarly collection of bamboo huts belonging to three of the five working companies. Here, as we could no longer make way against our evils, we resolved to take canoe and we dropped down stream without delay to Axim. The tornadoes had begun; the travelling season was ending, and three of the four mine-managers were on their way home.

A week's nursing enabled my companion to "pull himself together," and he again went up the Ancobra, in order to finish his survey of the river and the land—a map which he has carefully checked by astronomical observations. Well knowing his truly Caledonian perseverance, I made him promise that he would not fight too hard against fever. As for myself, my work was done. I came out to West Africa doubting, because others seemed to doubt, the possibility of successfully working her mines on a scale likely to pay. I return thoroughly satisfied. The obstacles, generally objected to and most dreaded, numbered four; these are—

1. The pernicious effects of Ashanti wars and scares.

2. The expense of transporting heavy machinery, and the troubles attending skilled labour in a wild country.

3. The labour question generally; and,

4. The climate, or rather the prepossessions against the climate which prevail in England.

Allow me, briefly, to show how I came to the conclusion that two out of the four are mere bugbears, and that the remaining obstacles are easily to be surmounted.

You have all heard of what the West African Coast, in 1880 and 1881, agreed to call the "Ashanti Scare," officially denominated in the Blue-book the "threatened Ashanti invasion." It was not wholly a "scare." The caboceers, or chiefs, crafty as Africans mostly are, were determined to try us. But when they saw the vigour of our preparations, ships and soldiers sent up from all directions to the Gold Coast, they simply collapsed. They gave up the absurd "gold-axe," which is supposed to symbolise war backed by wealth. The "scare" has done great good, by showing how weak the once mighty military power has now become. She is actually at war with her neighbour Gy'aman, and she cannot master even that one petty kingdom. In fact, the hideous little negro despotism, spoiled of her props, seems crumbling to her fall.

My doubts about transporting machinery were at once solved, when I found that some of our mines in the interior are actually using stamps and steam-engines, are crushing quartz and are amalgamating gold. But here I venture to assert that gold-getting has begun at the wrong end. I heard nothing of surfacing, sluicing, and hydraulic-mining by the jet—and similar simple and inexpensive processes. I could not learn that a single hill had been asked, or that a single rivulet-bed had been dug into for stream-gold and nuggets. I heard only of deep-sinking, shafting, tunnelling, and quartz-crushing. And yet, as I have said, the natives set us the example. Whilst the husbands sink pits to act as shafts, the wives pan the pay-dirt from "women's washings," and expect to extract from 40 to 50 lbs. of the gravelly soil immediately below the surface-humus between half-a-dollar and two dollars a day. *Probatum est!* Why not, then, begin at the beginning, and wash on the largest scale the overburden before attacking the rock? The proceeds of panning would purchase machinery and pay its transport; and, at last, when the hillocks are cleared of trees whose roots hide nuggets, and are levelled by the jet or sluice, the quartz-reefs will stand out, like those of Arabian Midian, in the form of stone walls. These will be worked by mere quarrying with the sledge-hammer, till the floor-rock is found. California owes her agricultural, and especially her viticultural, development chiefly to the hydraulic system, which, in a few years, prepared her surface for husbandry on a large scale. It will be the same with the Gold Coast.

As regards the labour question, there is no difficulty for the immediate present. The country people, Fantis, Appolonians, and others, are working on tribute, and are contracting for piece-work. At Cape Coast Castle there are still disengaged hands. But I here foresee extensive peculation; all these tribes know gold well, and have fingers like fish-hooks. The same is the case with the Krumen, who are found to work satisfactorily in some mines. This market, however, is getting tight; and although not more than 5,000 hands are employed on the whole Western Coast, the demand for some hundreds more would lead to a great eris in wages. When recruits are wanted, they may, perhaps, be raised in Yoruba-land, and in the Bassa and Drewin countries; of that, however, I am far from certain. Even when the five working mines are fully manned, there will be all manner of difficulties, and there will be a complete break-down when the number of companies shall rise from five to fifty. The only plan then will be to find a new labour-market, and here are, happily, no difficulties. For years the slow old West Coast has been talking of a Chinese immigration, the one thing wanted to galvanise the inert and paralysed body. The French have already sent a corps of Chinese workmen to begin their Senegal Railway. In due time we shall follow suit. My companion and I have worked out a project for supplying, not only the mines and the Gold Coast, but the whole of British West Africa with Chinese and Indian coolies; and, if others be wanted, with the sturdy and hard-working Wasawahili of Zanzibar. We shall be the greatest benefactors West Africa ever known.

It remains now to consider the question of climate. Topically speaking, it is equatorial, within five degrees of the line. But the nearer we approach the equator, the cooler and more equable becomes the temperature—a fact ignored by geography books. At Fernando Po, in north latitude 4°, I never slept without one blanket, and often required two. The cause is the canopy of vapour, which ever intercepts the solar rays, and which absolutely prevents sunstroke. At Axim we found the average daily temperature 75° to 80° Fahr., rising to 92° and 96° Fahr., and falling by night to 70° or 75°. There are only two seasons, the rains and the dries; the hottest weather, in our winter, is as bearable as that of Trieste in August. The unwholesome season follows the rains in September, the rule of the Nile valley. Yellow fever is unknown. There is no reason why a man who takes tolerable care of himself, and who is well lodged and fed, should not labour for years at the mines; at the same time, I should advise a trip northwards after each spell of eighteen months.

This climate-question, of which so much has been said in England, would hardly have occurred to an old coaster. When I hear a man enlarging upon the subject, I know him to be a theorist. The West Coast of Africa is not more unwholesome than was that of Western India when I was first stationed there; Bombay, as well as Sierra Leone, was once called the "White Man's Grave."

You will object that Captain Cameron and I both suffered from ague and fever during our short stay on the Gold Coast. "I thought you were fever-proof," has been said to me more than once; but a man is never fever-proof in Africa, and rarely cold-proof in England, at least, as long as he breathes the upper air. And we gave the climate no chance. New arrivals are advised by all old hands to avoid, for the first three months, over-exertion of mind or body. This, in our case, was equivalent to prescribing a generous diet of beefsteaks and port to a pauper patient. We had to do in 24 hours the work of 48; we walked instead of hammocking, the better to collect specimens; and my companion, after a heavy day's work, often sat for hours in the dewy night to make his observations. Nor did we stay long enough to become acclimatised. Under other circumstances, we should have passed, at the end of a month or so, through a mild seasoning of ague and fever; and, after the third month we should have been fit for any amount of exertion. I repeat, that, in our case, the climate had no fair play.

But look at things as they are. Of the four English managers of mines, three have retained vigorous health after years of residence in the Coast. Only one suffers from rheumatic gout, a complaint certainly not confined to Western Africa. As Mr. Walker told you a few days ago, we all know Englishmen who have lived a score of years, and many more, at Bathurst (Gambia) and at Freetown (Sierra Leone), and who have returned home hale and hearty. I see sundry in this room, as good men as if they had lived in England all their lives.

And now, permit me briefly to recapitulate. The good news we bring home is the prodigious wealth of the land; I know nothing to equal it in California or in the Brazil. Gold-dust is panned by native women from the sands of the seashore. Gold spangles glitter after showers in the streets of Axim. Gold is yielded by the lumps of yellow swish that revet the wattle walls of hut and hovel. Our washings range from half an ounce to four ounces per ton. In California, nine-pence pays.

There, then, is the gold, and it will be our fault only if it remains there. During the last century this section of the West African Coast annually exported to Europe between three and three and a-half million sterling of gold, in the shape of dust, nuggets, and bars. The abolition of slavery, and the manumission of "pawns," brought it down to an average of £126,000 during the last decade. Such, at least, is the calculation of the experienced Mr. Paulez Dahse;* but we have the very best of slaves, the machine which never tires, the steam-navvy, and the quartz-stamp. "Long Tom" and "Broad Tom" will do single-handed in a day the week's work of a gang. England also wants gold. A few years ago, her annual supply was twenty-five millions sterling, now it is reduced to eighteen. I see no difficulty in again raising the export of West Africa to the highest figure it showed during the last century, and I know no land better able to supply the measure required in England, to preserve the balance of the precious metals, than this old-new California, our neglected El Dorado, the Gold Coast.

I thank you for the honour you have done me in listening with such good will to a mere *resumé* of an extensive theme—such "boilings down" mostly lack savour. And, in a parting word, I venture to solicit your good will in favour of our proposed exploitation.

DISCUSSION.

Mr. Johns said he was engaged in these gold mining operations, and he felt very strongly that the labour question was of great importance. His idea was, that they should get all the companies engaged in the enterprise, to adopt some general system of importing Chinese labour, which had been found so valuable in California. It was evident that something of this kind must soon be set on foot, if the enterprise were to be as successful as it ought to be. The various tribes on the coast from which their supply of labour was drawn, understood each other very well, and unless something were done, they would soon find the price of labour rise against them. There were several companies now engaged, but he feared if they all acted on purely selfish motives, they would entirely break down; they wanted a spirit of union amongst them, in order, not only to import Chinese labour, but also to fix the price of European labour, to protect themselves in case of alarm, and other matters. He found great difficulty in the City, however, in getting other companies to take this view, but he hoped before long they would agree on a conference on the question of labour, which was the only one of importance. One or two companies he knew privately, would soon be sending home very important remittances, but he did not think there ought to be any secrecy in the matter; they ought to communicate everything to their shareholders.

Mr. Thomas Cornish said he went to the African Gold Coast last year, and as an old Australian miner, he was exceedingly well pleased with the prospect he saw there. He had samples which were washed out in his presence, showing the extreme richness of the titaniferous sand along the coast. Going up the Ancobra, too, there were many excellent "prospects," though they had not time to examine them carefully; he felt sure there were many places there which would pay well, both for sluicing and dredging. He was not able to go to Appolonia, being taken ill, and having to cut short his visit, but he could bear testimony to the good prospects for gold mining on the West Coast generally. The great difficulty, no doubt, would be the labour question: the West Coast being so different from Australia and California, where a white man could work hard from morning to night; and where food was plentiful. In Africa it was necessary to employ black labour; the Kroomen were very good workers, and soon learned how to use a pick and a drill; but when you were working with two or three of them in a level, at any depth, artificial ventilation would be very necessary. The wages were about 1s. 3d. or 1s. 6d. a day; and if the companies were to fix some such rate, it would be very fair, and the men could earn good wages at it. The question of white men's health would also have to be studied, and one very necessary thing would be to avoid over-indulgence in stimulants, for that was one of the greatest curses on the coast.

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* Page 2, band 5, "Deutsche Geographischer Blätter," published by the Geographical Society of Bremen, G. A. v. Halem, 1882. The reader will find the figures in page 102 of Mr. Dahse's most able paper, which amply deserves the honour of a translation. I am informed that this has already been done by Mr. N. Bruce Walker, jun.

Mr. **WALKER** did not think any European would ever be able to stand the climate of Africa without a moderate amount of stimulant. He had passed upwards of 30 years there, and he did very well on two bottles of whiskey a week. There was no doubt about the richness of the country, and it was only a pity that Captain Burton was not able to see more, because, from his large experience in other auriferous regions, his testimony was of the greatest possible value. With regard to Europeans' health, he had had a considerable number of carpenters and other men at work under him, besides sailors, and his experience was, that those who had plenty to do maintained their health much better than those who were idle.

Mr. **OLIVER PEGLER** said his experience on the coast led him to the conviction that Captain Burton's statement on the question of the richness of the gold in the lagoon were exceedingly moderate. He had spoken of from one to four ounces as being realised, but he had seen as much as twenty ounces on some occasions. This was a country which extended over 100 miles, and the sands of every river contained gold. On his visit, he made the best use of his time, and landed wherever the steamer touched, and for a thousand miles along the coast, there were evidences of gold. The geological formation was eminently typical of gold, particularly the alluvial strata, and these alluvial deposits were so gigantic, that the puny efforts of the natives in the past had made no appreciable impression upon them. They only went to a very shallow depth, and rarely, if ever, tunnelled, though he had seen some open trenches. They dug down a little way, and then enlarged the hole until it fell in, and then the fetish man stepped in and made them leave the neighbourhood. In one place he came across some old mines, perhaps 20 years old, where the natives had gone down 50 or 60 feet, when evidently a large mass of earth had fallen in, and the working had been abandoned, but the richness at that depth was very striking. In one place he came upon one thousand or two thousand natives busily engaged on a small area of a few acres, working in gangs, day and night, washing for gold. With regard to the labour question, no doubt the Kroomen were a splendid set of men, but when operations became much enlarged, he feared this source of labour would become very limited. He had seen gold mining in Venezuela carried on very successfully with Indian coolies, but, in his opinion, it would be better to have Chinese, as they possessed more strength, and were better able to shift for themselves. In Africa, however, there need be no lack of food. There was abundance of vegetable produce. A great many people threw cold water on this enterprise, on account of the climate, but when greater provision was made for comfort, sickness would decrease. If anyone had travelled in Britain 2,000 years ago, when it was covered with forests, and had been taken ill, he would probably have sickened and died. The West Coast of India was, at one time, as unhealthy as the West Coast of Africa, but Bombay was now one of the finest cities in the world. Demerara, again, was one of the healthiest cities, barring yellow fever. In all these tropical countries fever was the great evil, but he would rather live in Africa, with its chances of fever, than in England, with its east winds. If the companies would treat their workmen properly, they might live there very well. He had had some experience in India, and it was known that the South Wynaad district was considered very unhealthy; but he had insisted on the company with which he was connected paying every attention to the health of the miners, and having proper dwellings, and, he believed, they had not lost a single man. If they had good dwellings and food, there was not much danger. Nine-tenths of those who perished, did so through over-indulgence in stimulants.

Mr. **LIGGINS** said he had listened with great attention to these two valuable papers, but regretted to say that he had not learned anything from them which he did not know before. He had on his finger a ring, which he had had for 25 years, made from gold found at Cape Coast Castle, so that he had no doubt about gold being there, but that was no proof that it would pay to get it. Ballarat had sent nearly 300 millions of gold to this country, but it scarcely paid to get gold there now. He knew Demerara very well, but no one who lived there considered it a healthy place. He was always very well there, but he could hardly reckon the number of his friends who had died there. This did not altogether result from the climate itself, but the effect of the climate was to lead to self-indulgence; a man took one glass of grog, which did him no harm, and then took a second and a third; and then, perhaps, went to sleep in a damp verandah, and caught a chill, which led to what, in England, would be called influenza, but there was a fever; and this went on time after time, until he succumbed. The climate was a tolerable one for an English gentleman who knew how to take care of himself, but in the case of working men there was more difficulty. He could mention innumerable cases of working men whom his father and he had sent out there, who had been thoroughly well treated and cared for, but who could not resist that curse of the West Indies, the new rum, which finally destroyed them; not so much from its direct effects, as in the way he had mentioned, by leading to carelessness in other matters. He believed, therefore, that it would be utterly useless to send English workmen to superintend these gold mines. He knew a mine in British Honduras from which he had seen splendid samples of gold years ago; but it had never paid those who put their money into it, simply because it was impossible to get suitable labour. He had also seen gold 20 years ago which was found in Venezuela, or British Guiana, but they had never seen anything but samples. He had had experience of coolie labour in the West Indies, and of Chinese, and, in his opinion, the only way in which there was any chance of working these mines at a profit, was by means of Chinese labour.

Dr. HEWAN, being called upon by the Chairman to give his opinion on the climate of Africa, said he must begin by condemning what Mr. Walker had said about the two bottles of whiskey a week. There was no doubt that indulgence in spirituous liquor was the great cause of mortality on the West Coast. Indulgence generally led to over-indulgence, and in his experience, a great deal of the evil effects of the climate, so called, were really due to the manner of life in the climate. Some people overate themselves, and got bilious attacks, and when they ate they generally wanted something to wash it down with; he did not see why men should not enjoy as good health there as in many other tropical climates. No doubt it was moist and enervating, but you never heard of sunstroke there. If a man would avoid damp, drinking, and exposure at night, especially moonlight nights, he would do very well. The main thing was to avoid spirituous liquors; they were of use sometimes, no doubt, but they should not be taken habitually.

Mr. CHRISTIAN MAST wished to have some idea how far what was called the Ashantee scare was in reality a source of danger. He understood that behind the Gold Coast lay the kingdom of Ashanti, with a population of from four to six millions, and that the kings and kinglets of the interior were very desirous of having an outlet to the coast, which had caused the previous war, and might lead to further troubles.

Mr. HYDE CLARKE, said they might derive one comfort from Mr. Liggins's remarks, and that was that he did believe in Chinese labour. He was astonished that a man of his experience should say it was impossible to employ European labour in this district, because anyone of them who had been concerned in such operations knew that they could get men from this country to work in any part of the world, even under much worse conditions than those offered by a mining company in West Africa. Mr. Liggins spoke from his experience as a West India planter, but Captain Burton was talking of a different thing altogether; he was not speaking of employing casual European labourer on a sugar plantation, but of a distinct class of this country, the mining population. Those men would go to any part of the world where they were offered fair treatment and good wages; many of them were saving men, and therefore, sober men, and there was no doubt that a fair supply of them to superintend and instruct the native labourers could be obtained. A very important point raised by Captain Burton and referred to by Mr. Johns, was the importation of labour, and on that he must say a word from his own experience. Mistakes were often made about cost of labour. You heard that the average price of labour was 1s. a-day, or whatever it might be, and you might fancy that you could get the labour you wanted at that rate, but the moment you began employing a considerable number of men, you used up all the surplus labour and raised the price against yourself. The only practical mode of meeting the difficulty was by importing labour, as had been recommended, so as to swamp the results of competition among the local labourers. But there was sometimes a practical difficulty which ought to be mentioned. The employer had to pay the passage of the labourer, and then if he did not take care, the labourer might run away and get employment with one of his competitors. It would be very necessary, therefore, that some means of enforcing labour contracts should be provided; this was a point worthy the attention of the authorities on the West Coast, and when it was done, labour might be safely imported. The question of cheap labour was very thoroughly treated by Sir Thomas Brassey in his book entitled, "Work and Wages," which was founded on his father's experience; and he there stated that whenever his father carried out any large operations abroad he never calculated on the low price of labour in the country, but always on the English rate, and that he found could be safely taken as the standard. This might at first sight appear to be a paradox, but it was very fully explained and justified in the work he had mentioned. Mr. Liggins appeared to have been rather frightened at Captain Burton's statement as to the wages gained by the women in gold washing, but he derived considerable encouragement from it, because he understood that it included both the woman's work in washing, and also her husband's in digging the stuff, and if 2s. a day was the least amount earned under such circumstances, it was plain there was just the opportunity for the employment of capital and organisation. They were much indebted to Captain Burton for his information, which was the more valuable from his great experience in all parts of the world, and he had had an opportunity on this occasion to carry out the studies which he made as the translator of the great Portuguese poet, and the illustrations he had given of the voyages of the great explorer of the African coast.

Mr. **Martin Wood** asked if the British protectorate extended over the whole district described, how far it extended inland, and if there were any guarantee for security for life and property, as well as for the fulfilment of contracts.

Captain **Cameron** said a British Commissioner, and a force of British constabulary, were established as far as any of the mines, and the limits of the Protectorate were well known as to the boundaries of the various tribes, though they were not yet accurately defined geographically. It was not necessary for him to say anything about Captain Burton's paper, for they had worked hand in hand the whole time. They were both of opinion that immigration of labour was necessary for the whole West Coast, and that it would be provided best from China. At Lagos, a Frenchman told him he should be glad of 600 coolies for his commercial operations. He quite endorsed Mr. Cornish's remarks; he did a little dredging on the Ancobra, and the results looked very promising, though they had not been tested. He hoped the "flats" would be lifted by machinery, and worked down by sluices and "long toms." Ventilation he had seen managed very successfully by means of fans worked by hand labour, but immediately two galleries were put in communication with each other, so that there was an up and down current established, these difficulties would cease. Of course, in driving a heading, air would always be wanted to drive out the smoke after blasting. Mr. Pegler was an experienced mining engineer, and he endorsed his remarks, but he might add that in two places he had actually seen tunnels which had been driven by the natives. One of these was on the Ancobra, some distance from its junction with the Abunsa, where there was a tunnel driven in the bank (which communicated with a shaft) about 50 or 60 feet long, and some of the stuff in it was apparently very good. Mr. Liggins's experience was, no doubt, very valuable, but he believed more in what was told them by Captain Burton, Dr. Hewan, and other gentlemen, and there was no doubt that as the coast became better known, Europeans would live longer and more comfortably there. It was the same with other places. In 1857, Zanzibar was supposed to be so unhealthy that no one was allowed to sleep on shore, but when he was ill there with fever, Sir John Kirk sent him on shore that he might recover. Science was always progressing, and as people went more to new climates, they would adopt better means for ensuring their health. They might lose some men, but what struggle was there in which some lives were not lost for the benefit of humanity. The Ashanti scare simply showed the hollowness of the present Ashanti empire. He did not calculate labour at the English rate, but rather higher; he knew it cost £120 to build at Bombay, though labour was cheap, what you could build for £40 in an English dockyard. You ought not to calculate by the rate per day, but by the amount of work done for a given sum of money.

Mr. **Dipnall** said it seemed very difficult to get at the exact facts; one gentleman said the wages of a woman gold washing were so much; then another said that included her husband; one said the cost of labour might be calculated on the English scale, and Captain Cameron had first shown that this was not at all safe; so that an outsider was considerably puzzled to know how the matter really stood.

Mr. **Swanzy** said his firm had been in the African trade many years, and it was nearly four since they had embarked in gold mining. They then sent out an engineer, who accompanied his partner, Mr. Crocker, to several of the native mines, and they were so satisfied with his report that they spent a considerable sum of money, and sent out a good deal of machinery for the purpose of working for gold. They had as yet had no difficulty with the labour question, but had had to turn a good many away; the rate of paying being eight dollars a month. The manager of one of the other mines also told him that he found no lack of labour. Possibly when the time came, which Captain Cameron prophecied, when there would be fifty companies at work, there would be a lack of labour, but it had not arisen yet. With regard to the climate, if it was as bad as some people seemed to think, merchants could not carry on their business. They did not intend to send out Englishmen to do the actual work, but to instruct the natives, and see that it was done properly; they had had four or five at a time working there, and their health had been perfectly good; his partner had been up at the mines two years, and he held it was healthier there than on the coast. He might say in conclusion, that it was not a question of gulling the public in any way; his firm had been established fifty years, they had spent a good deal of money on this enterprise, and had very substantial returns to show.

Mr. **Andrew** thought one evening was much too short in which to discuss this question, on which there was much difference of opinion. He believed, however, there would be no difficulty whatever in getting a sufficient supply of labour.

The **Chairman** said the two main questions affecting this subject were those of climate and labour, on which various opinions had been expressed. Everyone admitted that there was a large extent of alluvial country full of gold deposit, which might be extracted, and the only two factors which had to be considered were, whether the climate and the supply of labour would enable Europeans to extract it at a profit, and without leaving their bones in the midst. It had been said of Demerara, that it was a very good climate if it were not for yellow fever, which rather reminded him of Gay's play of the "Beggar's

Opera," in which Polly had defended herself very vigorously against her traducers, by asking what there was against her character, "barring that she was a thief, and fond of the men." The great fault of Europeans, which had cost many thousands of lives, was that they continued the same diet which suited them in a cold climate, where they could take plenty of exercise, in the tropics. They would take a solid breakfast, then a luncheon, with champagne or other stimulants, then a heavy dinner at seven, and perhaps supper afterwards, with abundance of strong liquor; and of course they could not expect to retain their health. They would do much better to follow the example of the natives. They heard a great deal of what the Chinese could do; but their diet was almost exclusively rice and weak tea, with a little mild tobacco; and he was sure that if Europeans did the same, they would not be much the better for it. It astonished him very much that Africa, which had been for so many years the great storehouse of labour for the rest of the world; for Europe and America, more especially, with its continuous demand for slave labour, was not able to supply the labour for its own occasions. It seemed very hard to send to China for labourers to come and take away African gold, when there were so many millions of strong vigorous negroes there. If they were fairly paid and well treated he did not believe there would be any necessity for going to China for help; though he had no doubt any amount of labour could be obtained from thence. Even at the present day the slave trade was still carried on in Africa, and, however hardy the Chinese might be, he could not believe that people born in the country would not stand the climate better than strangers. He would not go into the question of teetotalism, but he could not help thinking that in the case referred to, the three glasses of grog would would do quite as much harm as sleeping in the verandah. Those who lived carefully, and, above all, temperately, might, no doubt, preserve their health in tropical climates; he had tried it for 25 years, and did not find that his health was seriously affected. Captain Burton had already immortalised himself by his great discoveries in connection with the Nile, and he had now done a great service by bringing forward the fact that there was this large quantity of gold in Africa, not deep down in the earth, but really on the surface; and he thought both the moot questions of climate and labour might fairly be answered in the affirmative. The latter he should certainly say might be met without going away from Africa. By utilising native labour in a legitimate way more would be done to root out slavery, than all the fine speeches and philanthropic efforts in other directions could ever accomplish. He concluded by proposing a hearty vote of thanks to Captain Burton.

The vote of thanks was carried unanimously, and the proceedings terminated.

Captain BURTON adds the following remarks to the discussion:—He perfectly agreed with Mr. Johns upon the important subject of unity and "solidarity" amongst the companies, for what benefits one mine benefits all. Mr. Cornish had stated facts concerning the washing and dredging of the Ancobra river; this was one of the late M. Bounet's pet projects. He agreed with Mr. R. B. N. Walker that two bottles of whisky a week do more good than harm. He regretted that Mr. Liggins had learnt nothing from the paper, and could only hope that all in that room were not so learned. But random statements cannot be accepted against facts; the four mine managers on the Gold Coast show that Europeans can live there, and can work there. He could not join in the total abstinence theories of Dr. Archibald Hewan; in these matters, every man must find out what suits him best. He thoroughly disagreed with two remarks made by the Chairman. The first was, advising well-fed Englishmen to live like Kroomen, or other natives; the experiment has often been tried in India, and mostly with fatal effect. The second, viz., the injunction to engage labourers, not in China, but in Africa. Throughout the Dark Continent, the free man objects to work, so this was virtually proposing a system of slave recruiting. The cry of "Africa for the Africans" reminded him only of "Ireland for the Irish."

Miscellaneous.

CULTIVATION OF GINSENG IN JAPAN.

The ginseng plant is of bushy growth, and belongs to the family *Araliaceæ*. It presents, in its cylindrical, dark roots, a medicine highly prized by the Chinese and Japanese. It grows wild in the shady mountain forests of Eastern Asia, from Nepaul as far as Manchooria, while, until very recently, it was found cultivated in Japan only. In the large forests of Chinese Manchooria, the first plants were discovered, and although these roots were carefully gathered, the amount was far too small for the demands of China, and thus its cultivation was started in Northern China, Corea and Japan taking part in the enterprise; yet, for several years, to supply the steadily growing demand, it was imported from the United States, where, in the neighbourhoods of Baltimore and Philadelphia, great quantities of *Panax quinquefolium* were gathered. The Japanese select for the cultivation of the ginseng tree, black and moist soil, as the only kind in which it will attain perfection, and become pure white, as if grown in ferruginous soil it becomes reddish, and is less valuable. The soil being well prepared and manured, it is then laid out in beds, always east and west, about 27 Japanese feet long, and 2½ feet broad, with a distance of 2 feet between each. To guard the plants from the direct rays of the sun, and from heavy rain storms, each bed is protected by a roof made of straw, and laid upon poles, supported on posts. In Southern Japan, as the provinces of Idzumo and Hoki, the planting takes place on November, and further North, in April. In the beds the seed is deposited two to three inches apart every way, so that there will be a distance of about a foot between each. It is of very slow growth, and takes three years and a half to attain its maturity—thus the fields will show the "ichi-nen-shô," or first year's growth; the "ni-nen-shô," or second year's; the "san-nen-shô," or third year's;" and the "shi-nen-shô," or fourth year's growth. The first year's growth has but two leaves, and no stem, while the leaves, somewhat resembling clover leaves, are egg-shaped, and very much dented. In the second year, a smooth stem appears, which, at the top, divides into two or three little branches. The last year's branches are now finger-shaped, five in number, and symmetrically developed, especially the middle one, but beyond this, there is no change from the first year. The third year, the plant half-way up develops a wreath of clover-shaped leaves, the middle one of which is like the second year's growth, slightly more developed than the rest; the stem and branches are now of a nut-brown colour. The flower-bud starts from the base of the leaves when a small flower appears at times, accompanied by a second one, slightly to one side, or farther back towards the stem of the plant, but these are removed unless seeds are required. The seeds, after being gathered, are buried in the ground to a depth of one or two feet, to preserve their germinating power. The harvest takes place in July and August of the fourth year. The roots are cylindrical in shape, about as thick as a finger, white, and often prong-shaped towards the lower end. When fresh, they generally weigh 20 to 25 grammes. After digging out the roots, they are freed from all dirt adhering to them, and then carefully washed, after which they are scalded in boiling water or steam, so as to appear of a yellowish-brown hue, when the cross insertion is made. They are then laid on shelves, and according to size, exposed for two to eight days, to a heat averaging 100° to 120° Centigrade, after which, they are perfectly dry and fit for market. They are also successfully dried in the sun. When ready for market, ginseng is yellow or brown, semi-transparent, brittle, and of a slight bitter taste, and great care must be exercised to guard it against dampness. Of the stem and leaves, a jelly is prepared which, in taste, somewhat resembles liquorice; it, however, possesses a slightly bitter taste. This is never exported. The price usually obtained for prepared ginseng root is from 5 to 7 yen per kim, that is, about 20s. to 30s. per pound; while in China, the price amounts to as much as £2. Manchooria ginseng root is still more valuable, and is often paid its weight in silver, six or sevenfold. It is annually exported to China, the revenue derivable therefrom amounting to £37,500 per annum.

Correspondence.

MR. ROBINS'S PAPER ON TECHNICAL EDUCATION.

Mr. George N. Hooper sends the following communication on the subject of Mr. Robins's paper:—

"My experience, as Chairman of a technical and drawing class for six years, is, that the workmen are in advance of the employers in appreciation of technical education. The School Boards are leavening the masses. My own practice is, that all boys engaged have to attend technical classes, for which my firm pays the fees. I have recently been acting with a body of working men, to get their views placed before the Royal Commissioners on Technical Education. Under certain conditions, arranged beforehand, they had an interview, and in half-an-hour the Royal Commission found the men had very intelligent views on the subject. Technical schools should be in the immediate neighbourhood of the trades, and the young men and lads would do well with two hours' technical teaching, three times a week, and with very little loss of their own or employers' time. One of the advantages of trade workshops would be that sons of employers could be taught the use of tools and the qualities of materials, to enable them to judge between good and bad; in some cases well educated young men have great repugnance to the rougher life of the workshop, and in others they sink to the level of the workmen—and sometimes lower. Workmen have more respect for employers who can handle tools well, and are really good judges of workmanship and materials. One of the results of the technical and drawing classes I assisted in establishing is, that many of the students are earning higher wages or salaries; some have doubled theirs, others more than doubled theirs; and one has become an employer. Many employers are excessively harrassed to get work properly done at present; far too much strong drink is absorbed for men to take pride in good work; it blunts the senses, and makes the man too much of an animal for high class work. The teachers that workmen follow and respect are those who have mastered their trade, and have studied science and art, and are able to explain their adaptation to the workman's everyday wants and difficulties. Froebel's kindergarten system is wonderfully adapted as a foundation on which to build technical education, it helps to overcome awkwardness in children, and makes them handy. The want of technical education is at the root of much of the trade depression in England, and until the people become more temperate, they cannot compete with trade rivals who keep their heads cool and their brains clear. Technical training in France is carried beyond trade schools and workmen's classes; there exists at Rouen a High School of Commerce, at which young men are trained as merchants, and few persons in England have any conception of its thoroughness, and the excellence of its teaching; besides, it is becoming somewhat common in France now, for young men to take their university degree before engaging in manufactures."

Mr. Hooper also sends a table of the receipts and expenditure of the St. Mark's Technical and Drawing Class for Coachmakers, for the five years 1876-7 to 1880-1, from which it appears that the number of students in 1876-7, was 30, and the number in 1880-1, 60. The average annual expenses during five years was £71 14s. 6d.; the average cost of instruction for each student, £1 13s. 4d.; and the average receipt for each student, 8s. 1d.

General Notes.

TELEGRAMS AND TELELOGUES.—The following figures show the comparative daily return of Post-office telegrams and of telelogues of the United Telephone Company. The average number of telegrams sent have risen from 7,800 in London, and 14,500 in the provinces, in 1871, to 31,700, London, and 37,200, provinces, in 1881. The average daily number in intermediate years was as follows:—

	London.	Provinces.
1872	9,900	18,050
1873	12,800	21,970
1875	15,500	27,740
1877	18,000	30,770
1878	18,300	30,900
1880	27,000	33,900

Of telelogues in London, the actual highest daily number in each month was in 1881, 11,118 for July; and 20,646 for December. In January of the present year, the number was 20,294; and for May, 28,614.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 5...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. T. M. Rymer-Jones, "Railway Tunnelling in Japan."

Institute of Surveyors, 12, Great George-street, S.W., 3 p.m. Annual Meeting.

Society of Chemical Industry (London Section), Chemical Society's-room, Burlington-house, W., 7¾ p.m. 1. Professor Armstrong, "Turpentine—its Nature and Adulteration." 2. Mr. W. J. Lovett, "Testing of Chimney Gases." 3. Mr. G. E. Davis, "The Estimation of HCl Free and Combined in Chimney Gases."

British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 6...Royal Institution, Albemarle-street, W., Professor A. Gamgee, "Digestion." (Lecture IV.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Biblical Archæology, 9 Conduit-street, Hanover-square, W., 8 p.m. 1. Mr. E. Lund, "The Epoch of Joseph: Amenhotep IV., as the Pharoah of the Famine." 2. Prof. A. H. Sayce, "The Decipherment of the Hittite Inscriptions."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. St. George Mivart, "Notes on some Points in the Anatomy of the *Æluroidea.*" 2. Mr. Howard Saunders, "A Collection of *Laridæ* from the Coasts of Peru and Chili, made by Captain A. H. Markham, R.N." 3. Mr. E. J. Miers, "Crustaceans collected by M. V. de Robillard at the Mauritius." Part II. 4. Prof F. Jeffrey Bell, "An Attempt to apply a Method of Formulation to the Species of the *Comatulidæ*, with the Description of a new Species."

WEDNESDAY, JUNE 7...Royal United Service Institute, Whitehall-yard, S.W., 3 p.m. Discussion on the subject of the Naval Prize Essay on "The Best Method of Providing an Efficient Force of Officers and Men for the Navy, including the Reserves; the subject of Naval Education being also included."

Geological, Burlington-house, W., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. J. T. Irvine, "The Sculptures of the West Front, Lichfield Cathedral." 2. Dr. Alfred C. Fryer, "Cuddy's Cove, Northumberland." 3. Dr. Josh. Stephens, "British Urn Burials at Basingstoke."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, JUNE 8...Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. H. P. MacCarthy, "The Present Position of Sculptural Art in this Country."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewars, "The Metals." (Lecture VIII).

Inventors' Institute, 4, St. Martin's-place, W.C. 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JUNE 9...Society for the Protection of Ancient Buildings (at the HOUSE OF THE SOCIETY OF ARTS). Annual Meeting.

Royal United Service Institute, Whitehall-yard, 3 p.m. General Sir Orfeur Cavenagh, "The Indian Army."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Burdon Sanderson, "The Sensibility of Plants."

Astronomical, Burlington-house, W., 8 p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. F. J. Furnivall, 1. "Some of Shakspere's Thoughts on Life and Death." 2. "The Cruxes in Shakspere's Early Comedies."

Quekett Microscopical Club, University College, W.C., 8 p.m.

SATURDAY, JUNE 10...Geologists' Association, University College, W.C. Excursion to Hayward's Heath and Ditchling Beacon (Southern Valley of the Weald).

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. W. F. Stanley, "Experiments on Vibration." 2. Mr. Walter Baily, "A Wind Integrator."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m Prof. D. Masson, "Poetry and its Literary Forms." (Lecture IV.)

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FRIDAY, JUNE 9, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the South Kensington Museum, by permission of the Lords of the Committee of Council on Education, on Wednesday, 14th of June.

Promenade concerts will be given by the Band of the 1st Life Guards in the North Court, and by the Hungarian Band in the Lord President's Court.

A vocal and instrumental concert, consisting of glees, &c., by the Royal Criterion Handbell Ringers, will be given from 9 to 11 o'clock, with intervals, in the Lecture Theatre.

Miss Helen Hopekirk will give a pianoforte recital in the Picture Gallery.

The galleries containing the Raphael Cartoons, the Sheepshanks Collection, the Wm. Smith Collection of Water Colour Drawings, the Dyce and Forster Pictures, and "The Chantrey Bequest," will be open.

The courts and corridors of the ground floors will be open. The reception will be held in the Architectural Court, by Sir Frederick Bramwell, F.R.S., Chairman, and other members of the Council.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Exhibition was opened on Wednesday, 24th ult., and will remain open (every day from 10 to 4, Saturday 10 to 2) until Friday, 30th inst. Members of the Society are admitted on signing their names, and can admit friends either by use of the tickets supplied for the evening meetings and lectures, or of their visiting cards.

A catalogue of the Exhibition was given in the number of the *Journal* for May 26th.

PRACTICAL EXAMINATIONS IN MUSIC.

At an examination held at the Convent of Nôtre Dame, Mount Pleasant, Liverpool, on May 15th, by Mr. W. Alexander Barrett, Mus. Bac. Oxon., one of the Society's examiners, 39 candidates presented themselves. Of these, 24 were examined in pianoforte playing, three for singing, and 12 for playing and singing, only two failed, and the remaining candidates gained 23 first-class, and 26 second-class certificates.

It may be desirable to remind Secretaries of Institutions that these examinations can be arranged for at any centre where not less than 30 candidates are reported as desirous of being examined.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Thursday, May 25th; B. Francis Cobb, Treasurer of the Society, in the Chair.

The paper read was—

RECENT PASSAGES OF ZULU-KAFIR HISTORY.

By Robert James Mann, M.D., F.R.C.S., F.R.G.S.,

Recently Superintendent of Education in Natal.

Many of the members of the Society of Arts will, no doubt, still have in their memory the interesting memorandum concerning the early history of the Zulu Kafir race, which was communicated by Sir Theophilus Shepstone, in the early part of 1875, and read at a meeting of the Society by the author of this paper, and also the sketch of the same people, contributed three years afterwards, by Mr. F. B. Fynney. Since that time, events have occurred in connection with the history of the Zulu Kafirs which are likewise deserving of notice and record, on account of the additional light which they throw upon the views that were then advanced in those communications.

In alluding to Mr. Fynney's account of the position and character of the Zulu chief, Cetywayo, at that time in the full ascendancy of his power, the author, in 1878, stated his conviction that this chief was far too keen an observer, and too shrewd a man, not to be aware of the invincible power of England; but that there was, nevertheless, the danger that, under the irresistible force of the general current of events, he might drift into war, and that if he did, the real weakness of his rule, which was so essentially based upon cruelty and terror, would become manifest with the first turn of fortune against him; and that he would, in all probability, disappear from the scene as suddenly and as summarily as his great-uncles, Chaka and Dingaan had done.*

This prophecy has been so far fulfilled, that Cetywayo did drift into war, and that he is now a prisoner in Cape Town, with the bands of his cruel despotism broken up. He has disappeared from the theatre where the conflict with the English power was carried on. But there are some incidents in the circumstances by which this memorable change has been brought about that are deserving of remark, and perhaps not the less so because, under the strange and unanticipated turn that has been taken by events, it has recently been spoken of as probable that the captive may yet pay a ceremonial visit to England, and make his appearance in an altogether different *rôle*. If this should come, and if the royal elephant of Zululand should, in this way, succeed to the position of favour in the public mind which has recently been vacated by the other elephant, Jumbo, it may not be amiss that some part of his past career should also be kept in remembrance. At any rate, the matters to which attention will be here drawn, are certainly pertinent to the operations of the Society, on the ground of the influence which they will assuredly exert upon the progress of civilisation and industrial development in South Africa.

When Mr. Fynney's paper was communicated to the African Section of the Society of Arts, in the early part of 1878, the complications in Zululand were hastening on to the rupture which finally issued in the conflict that was known as the Zulu War. The recognition of Cetywayo's succession to the supreme chieftainship in Zululand by the British Government took place in 1873; and in 1876, the new king seems to have given a quite unmistakable indication of the spirit in which it was his intention to rule. In that year, a rumour having reached the Government of Natal that he had ordered the slaughter of a number of young girls, who had manifested an unwillingness to be married to the soldiers of one of his veteran regiments, in accordance with an old custom, a remonstrance was sent to him, recalling to his mind the circumstance that he had pledged himself, at the time of his accession, to abandon all the cruel practices and traditions of his predecesors. There is some uncertainty and question as to the number of victims who were sacrificed upon this occasion. In the reports that were first made to the officers of the Natal Government, it was said that a very considerable number had been killed, and that the dead bodies had been laid at the intersection of the frequented cross-paths, to act as a warning to others who might feel inclined to disobey the royal command; and it was also reported that several of the relatives of the victims had been also killed, because they had removed the dead bodies for burial without the permission of the king. The apologists of Cetywayo, on the other hand, affirm that, at most, not more than five or six girls had been killed; that the laying of their bodies in the cross ways was merely of the same character as the not very remote hanging of executed criminals in chains in England; and that the case was simply one of judicial punishment, administered for the vindication of the King's paternal authority amongst his people. The contention, however, is of no practical moment, since, when the remonstrance was made to Cetywayo by the Governor of Natal, Sir Henry Bulwer, the chief's reply was to the effect that "he did kill, and meant to kill." He not only admitted, but justified the act, and defiantly proclaimed that he had only just began a practice in which it was his intention to persevere. His own words are, however, the best evidence on this point. When he received the Lieutenant-Governor's protests, he answered his message in the following now memorable words:—

> "I do kill; but do not consider yet I have done anything in the way of killing. Why do the white people start at nothing? I have not yet begun—I have yet to kill; it is the custom of our nation, and I shall not depart from it. Why does the Governor of Natal speak to me about my laws? Do I go to Natal and dictate to him about his laws? I shall not agree to any law, or rules from Natal, and by so doing throw the great kraal which I rule into the water. My people will not listen unless they are killed, and, while wishing to be friends with the English, I do not agree to give over my people to be governed by laws sent to me by them. Have I not asked the English Government to allow me to wash my spears since the death of my father Umpanda, and they have kept playing with me all this time, and treating me like a child. Go back and tell the English that I shall act

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* See *Journal of the Society of Arts*, vol. xxvi, page 123.

on my own account, and if they wish me to agree to their laws, I shall leave, and become a wanderer; but before I go, it will be seen that I shall not go without having acted. Go back, and tell the white man this, and let him hear it well. The Governor of Natal and I are equal: he is Governor of Natal—I am governor here."

Simultaneously with the delivery of this defiant message, it was reported to the High Commissioner at the Cape that messengers from Cetywayo were traversing South Africa in all directions, with appeals to the native chiefs to aid him in a struggle with the white man that was impending. Sir Bartle Frere having carefully examined into the ground of these reports, quite unwillingly arrived at the conclusion that they were substantially true; that an organised scheme was in progress for the overthrow of the white man's supremacy; and that Cetywayo was at that time engaged in an attempt to bring about a rising and coalition of the native tribes throughout South Africa. In the month of July in the following year, two Zulu women, who had fled for protection into Natal, were pursued by an armed band of Zulus, and were taken back across the frontier in the presence of a small party of Natal policemen, who were powerless to prevent this violation of British territory, and it is believed that these women were killed as soon as they reached Zululand. The ill-feeling of Cetywayo was no doubt materially strengthened and increased by the annexation of the Transvaal, which occurred in 1877, as a dispute regarding frontier land, which was pending at that time between Cetywayo and the Boers, was by that act transferred to the British. It appears that, soon after the annexation, two Zulu spies were sent to Pretoria, the capital of the Transvaal, by Cetywayo, to gain information as to the state of the matters there. These men put on the left-off clothes of two native policemen, and remained at Pretoria to see the military display on the occasion of the Queen's birthday. They subsequently returned to Cetywayo, and reported that the British soldiers looked very well at play; but they doubted their ability to be of much use in bush countries. "We, for instance," they said, "could in five minutes massacre that little body in our country." The agents of Cetywayo tried to get a look at a Gatling gun, but they failed, because the machine was always guarded by some ugly fellows, who, they understood, had just returned from murdering and impaling Secocoeni's poor women and children. Somtseu and his Banthla (the administrator of the Transvaal Government and his officers) looked very fine; they had on all their talismans of war. When these capable envoys returned to Zululand with their report, Cetywayo seemed to be perfectly satisfied with them for the service they had performed, and "gave them each ten head of cattle as a reward," which was assuredly not more than they deserved. There can be no doubt that at this time the secret service department of Cetywayo was better administered than that of his more highly civilised antagonists.*

Upon a careful consideration of the general progress of events, there can be no reasonable ground to doubt that Cetywayo had long cherished the idea of following in the footsteps of his great predecessors, Chaka and Dingaan, and that, throughout the early period of his career, he had pursued this purpose with consummate ability and skill. By a pretended acceptance of the conditions of the Natal authorities, he, in the first instance, secured the advantage of their recognition of his succession to the chieftainship at the period of his father's death. At a still earlier time, and before the annexation of the Transvaal, he very adroitly played the Boers off against the English. In 1861, he sent a message to the Boers, repudiating altogether any alliance with the English, and humbly placing himself at their disposal. That, however, was when he wanted to get back two fugitive brothers, and, as he thought rivals, Umtonga and Umgthwala, out of the hands of the Boers. In 1873, he proposed to the Natal Government that they should take the land which was in dispute between his people and the Boers. That was when he wanted to make sure that the English would not adopt any rival candidate for Umpanda's vacant seat. After the annexation of the Transvaal by Sir Theophilus Shepstone, he made overtures to the discontented Boers to avenge themselves, by joining him in a struggle against the English; and during the whole of this time, he was assiduously filling up the ranks, and drilling the recruits of his regiments, after the time-honoured example of Chaka, at his military kraals; and, to the best of his ability, adding guns to the original armaments of his warriors. The old system of Chaka, which constituted every able-bodied man of the tribe a soldier, was steadily maintained; the regiments were exercised at the great military encampments during a considerable part of the year, and the soldiers in these regiments were not allowed to take wives until they were well advanced in service and years; and then entire regiments were married of at once, at the word of command; signal vengeance being taken, as has been already seen, upon the young women when they ventured to disregard the royal order.

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* "The Zulus and Boers of South Africa." By Robert James Mann, M.D. Stanford, London, 1879. Page 71.

Immediately before the outbreak of the Zulu war, the population of Zululand, under Cetywayo's rule, was estimated at 250,000 individuals, and of these, about 40,000 were conceived to be then capable of bearing arms, and embodied in the regiments. The internal affairs of the ambitious chief were, however, so managed, that nothing was absolutely certain in reference to these numbers. It was known, however, that whatever they might be, they were unquestionably exceeded by the ranks of the loyal natives who were living in Natal, under British rule. In the year 1838, there were not more than 10,000 natives gathered round the white settlers in Natal. In 1843, when Natal first became a British colony, their numbers had grown to be 100,000. In 1866, they were estimated at 200,000. In more recent years, the returns of the Natal Government, based on the hut tax, gave as the approximate numbers, in 1873, 279,000; in 1874, 281,000; in 1877, 290,000; and in 1878, 321,000. This increase of the native population in Natal, it will be understood, was in the main due to the constant drain from Zululand, of people who sought to escape from the Zulu chief's despotic rule. With only a river between the Zulu and the British territory, it was quite impossible to prevent this wholesale readjustment of the numbers of the neighbouring states. The author of this paper had, at one time, under his care a young Zulu lad, who had crossed the river, with three or four relatives, in the dead of the night, when several other members of the family had been killed by the orders of Cetywayo, in consequence of some of them having been suspected of carrying messages to refugees in Natal. The author chanced to be near the frontier river just at the time when the escape into British territory was made, and in the early morning heard the account which was given to the border magistrate of the reasons for the exodus. The small party had travelled during the night, concealing themselves from time to time in the thick bush, and in terror of their lives. The practice of the colonial authorities, at this time, was to protect all refugees of this character, but to return any cattle they might attempt to bring with them. The refugees were, for the most part, placed under the care and in the service of white settlers in the colony for three years, as a kind of gentle check upon the practice. But, as a matter of fact, vast numbers of fugitives were constantly received, and incorporated into the native reserves of the colony, without the fulfilment of this condition. This wholesale and voluntary exodus of the Zulus into the British territory continued uninterruptedly for a long series of years, is the most forcible comment that can possibly be conceived upon the occasionally urged statement that the rule of Cetywayo has, at any time, been a really merciful and popular one. The incident of the seizure of the refugee women, and of their forcible reclamation and removal from the land of refuge by an armed band, which has been alluded to, and which played so important a part in the ultimate rupture and war, is a further very apt illustration of this phase of the subject.

Under the decision which had been come to by Sir Bartle Frere, upon the consideration of the various matters which have here been alluded to, an official and authoritative communication was made to Cetywayo towards the end of 1878, requiring him to disband his regiments, and receive a British resident; to furnish assurance against the summary infliction of death without legal trial; and to give up for trial before the law courts of the colony of Natal, the men who had recently made themselves responsible for armed violation of British territory.

There can be no doubt that these demands of the British authorities upon Cetywayo were virtually a conditional declaration of war. But they were as manifestly and indisputably a declaration of war in the interests of peace. There was no lurking design contained in them for the acquisition of territory, or for the extension of rule. There was no lust of land, or desire for dominion. They were the practical and not unnatural answer to the authoritative announcement of Cetywayo that he meant to kill at his own sweet will, and to the substantial demonstration of the fact that he by no means intended to limit his killing propensities to the land which came under his rule by hereditary descent. There can be no doubt that the inspiration of this demand was an honest, a brave, and a righteous one. The purpose was simply to stop the headlong career of an unscrupulous and blood-stained despot, who had grown bold in his own conceit, and who was bent on staining the land with blood, in order that his young warriors might get a crimson baptism for their spears, and in order that he might strengthen the foundations of his rule by an appeal to the as yet unforgotten traditions of the glories and renown of Chaka, the great originator of the system of Zulu despotism, and the head of his own dynasty.

The events which immediately followed the High Commissioner's demand, remarkably and conclusively prove that this is a correct representation of the position. The ultimatum was delivered to a deputation of Cetywayo's head men, sent to the frontier of Natal to receive it, on the 11th of December, 1878. Cetywayo endeavoured to gain time, by professing a desire to negotiate; but he did nothing to indicate any serious intention of meeting the demand; and on the 11th of January, 1879, Lord Chelmsford crossed the boundary river into Zululand with a column of English soldiers, to enforce the decision of the High Commissioner.

The plan of the campaign, which had been prepared by Lord Chelmsford, was to march upon the royal kraals in the heart of Zululand, by four columns, which were to concenter at Ulundi, at a distance varying from 60 to 100 miles from different points of the frontier. He himself led one of the two central columns of the four which crossed the Buffalo River at Yorke's Drift, or ford, about 100 miles above the sea mouth of the Tugela, the large stream of which the Buffalo is an affluent, and in a direct line between the Natal up-country township of Ladysmith and Ulundi. At the end of ten days, the General had advanced his camp about ten miles, to the spot which has now become so sadly famous as Isandhlwana.* The camp was pitched under the precipitous face of this paunch-shaped hill, and consisted of two guns, six companies of the 24th regiment of infantry, 104 mounted volunteers, and 800 native auxiliaries. The General himself went forward a day's march with the rest of the column to reconnoitre, and to select ground for the next encampment, and the camp in the meantime was not entrenched, because it was apparently covered by the General's advance, and because it was intended that it should be moved immediately after the advanced column. On the morning of the 22nd, however, before the camp had been moved, an overwhelming force of armed Zulus, who had evaded the notice of the advanced column, burst suddenly upon the camp, before there was any time to organise a defence, and entirely exterminated its occupants. It has never been made altogether clear whether this surprise was a part of a skilfully-laid plan, or whether it was a mere accident, the Zulus coming unexpectedly on the post whilst on the march to the Buffalo to repel the invasion. A Zulu prisoner, subsequently taken, who had been with the attacking force at the time, stated that it consisted of 20,000 men, and that it left the military kraal of Unodwengo, Umpanda's chief place, beyond the Umvolosi River, on the 17th of January, with orders to drive the English soldiers back across the Buffalo. It appears that the Zulu force spent the night of the 21st of January within four miles of Isandhlwana Hill, but concealed from it by intervening heights. Lord Chelmsford and his staff were observed by the Zulu scouts at sunset, on some hills towards the south-west. On the morning of the 22nd, some mounted volunteers from the camp were seen, endeavouring to cut off a drove of cattle, and the Zulus then rushed forward, on this provocation, to the attack. A small portion engaged the attention of the mounted men, and of two companies of the infantry, which had been pushed forward for their support, whilst the main body descended the hills flanking the Isandhlwana, and enveloped the camp with a sudden rush. The attack was made in the old traditional form conceived and taught by Chaka. Two lateral masses advanced, in the shape of projecting horns, until they closed round the small band of their antagonists, and the main body then burst upon them like a torrent. It is a notable circumstance that, in this formidable movement, the horns are constituted of streaming men, who continually surge on and on, like flowing water, the more backward men passing round those who are before them, so that any opposing force which endeavours to stop the advance is soon enveloped in the rushing mass of those who fold over it from the sides. The only chance of escape appears to be for the enclosed men to burst through between the points of the horns before they meet. It had been anticipated that the Zulus could not advance in the face of the rapid and sustained fire of the British infantry, and a large measure of reliance for the defence of the camp had been placed upon this assumption. As a matter of fact, upon this occasion the Zulus did advance in the face of such a fire, without a pause, and notwithstanding a very heavy loss; and they did so with so much celerity, impetuosity, and resolution, that it almost immediately became a hand to hand fight, in which the short, handy assegai, or lance, of the Zulus was a more effective weapon than the unwieldy bayonet of the soldiers. With the odds at more than twenty to one, in such a struggle, there could be no question as to the final result. The slaughter of the Zulus was very large, but as they persisted in their attack, their numbers told in the end. The Zulus have been described by some few survivors of the conflict as appearing almost to grow out of the earth. Scores of men—some armed with rifles, and some with shields and assegais—in the first instance, rose from every rock and bush around. The head of an immense advancing column then opened out upon each flank, until it had encircled the camp, a vast horde pouring down at the same time from the heights beyond. They were evidently inspired with the design of crushing the camp by sheer weight of numbers, and this purpose was resolutely carried out, although the victory probably cost them not less than 2,000 men. As the overwhelming mass came on, the advanced party of the English retreated, and in good order, towards the camp. But the native levies associated with them gave way, and rushed through their ranks in panic and confusion. When the horns of the Zulu formation had nearly met, they closed in suddenly, with a subdued humming noise, and the hand to hand fight and massacre immediately commenced; the few who escaped were a handful of men who broke through the remaining gap the instant before the closing of the horns, and these fled first, across three or four miles of broken ground, hotly pursued by the fleet-footed savages, and then down a steep descent, into the Buffalo river, in the rapid current of which nearly one hundred of the fugitives were drowned. As soon as the Zulus had taken possession of the camp, and exterminated its defenders, they turned their attention to plunder, and retired with their booty to their encampment of the previous night, and the next morning dispersed with their spoil. Lord Chelmsford, who had received some hazy impression that all was not right at the camp, made a hurried march back, and when he reached it in the dusk of the late evening, found the guns, ammunition, and stores all gone; and the ground covered with the bodies of the troops, who had fallen almost to a man in the gallant but hopeless struggle. After bivouacing for the night amongst the dead, he continued his retreat to Rorke's Drift, on the Buffalo River, where a splendid defence against a subsidiary attack had been made, as is now historically famous, by eighty men. The plans of the campaign were, however, paralysed for months, and a small army had to be sent out from England to retrieve the disaster. It was in this way, therefore, that Cetywayo justified, at the very opening of the campaign, the epithet which had been applied by Sir Bartle Frere to the Zulu organisation, when he spoke of it as a powerful man-slaying machine. The surprise at Isandhlwana, at the very outbreak of the war, must be taken as the practical commentary upon Cetywayo's memorable defiance to the Governor of Natal, in 1876; the substantial interpretation of those ominous words, "I do kill, but do not consider that I have done anything in the way of killing yet. Why do the white people start at nothing? I have not yet begun. I have yet to kill; it is the practice of our nation, and I shall not depart from it." It is said that in the attack at Isandhlwana about a couple of shots were fired, four or five assegais were hurled, and then the overwhelming masses of the Zulus were in at close quarters upon the camp. Scarcely more than an hour-and-a-half elapsed between the time when the Zulu scouts were first seen upon the surrounding hills and when the camp was in the hands of its assailants, and its defenders prostrate and quiet upon the sod. It is quite possible that this disastrous conflict was a mere accident, and that in their advance towards the Natal frontier the Zulus stumbled upom a lucky chance, and were prompt in availing themselves of the opportunity. The alternative hypothesis that it was a portion of a well-laid plan—in pursuance of which the main body of the Zulu army was hurled upon the weak point of the enemy, whilst he was kept in play in all other directions by subordinate and less serious attacks—is, however, supported by the apparently significant facts the Zulus were only allowed to march deliberately about nine miles a day, and that attacks were made upon Colonel Wood's column in the north, and upon Colonel Pearson's column in the south, at the same time that the conflict at Isandhlwana occurred; and that the attack was delivered upon the weak point at the right moment.

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* Pronounced "Isandthlwana." The name is the designation of a hill, which is so called because it bears the form of the small paunch, or stomach, of an ox.

Two important lessons are brought home to the civilised apprehension by this startling event. In the first instance, there is the most unwelcome consideration of the terrible nature of a conflict with a barbarous foe. A reverse means the utter extermination of a vanquished civilised force. This is an unavoidable concomitant of the struggle. There can be no such thing as surrender, or quarter; there can be no conditions or terms under defeat. The conditions of the struggle on the part of the civilised portion of the combatants is, literally and essentially, victory or death. The avowed tactics of the barbarous foe are the sudden and stealthy surprise, the overwhelming onslaught, and the extermination of the foe. This was the great secret of Chaka's success. It was by this means that, before the civilised occupation of South-Eastern Africa, the Zulu despotism swept like a baleful pestilence over the land. It is quite marvellous, after the event, to mark how singularly the slaughter at Isandhlwana, in 1879, in many of its most essential particulars, resembled the slaughter of Relief's party at Dingaan's kraal in 1838.* Contemplated in the light of this resemblance, there can be no doubt of the part which it was the intention of Cetywayo to play. He intended to show that the spirits of Chaka and Dingaan were still stalking upon the earth, and ascendant again in the field of their old supremacy. But there was one element which, in his overweening pride and self-confidence, he had not taken into account, the impracticability, namely, of keeping any barbarous onslaught to the point of a sustained effort. This difficulty was as great in Cetywayo's time as in the days of Chaka's devastating raids. A campaign, to the Zulu mind, is a succession of cattle-sweeping and man-stabbing excursions, and the smallest check is sufficient to reverse the whole fortunes of the war. After each successful blow, the assailing host disperses with its plunder, and has to be reassembled and brigaded again at one of the royal kraals, before it can be launched once more against the enemy. It is very remarkable how this peculiarity was illustrated at Isandhlwana. On the evening of the fight, Lord Chelmsford found the field a deserted waste, only held by the dead, notwithstanding the overwhelming host by which it had been occupied a few hours before. The gallant stand which was made by 80 brave men at Rorke's Drift, on the Buffalo river, sufficed to roll back the barbarous outburst, and to scatter the incoherent force that had achieved the unexpected onslaught. The firm tenacity with which the entrenched and hastily fortified posts were held in Zululand, by Colonel Evelyn Wood in the north, and by Colonel Pearson in the south, sufficed, in their turn, to paralyse the strategy of Cetywayo, and in all probability, saved the colony of Natal from the disasters of an invasion.

The attempt was made to repeat the surprise of Isandhlwana upon a smaller scale, at the Intombe river in the north. At daybreak, of the 11th of March, a camp of twenty waggons and 104 men of the 80th regiment of infantry were attacked, during a thick mist, by 4,000 Zulus, under Umbelini, one of Cetywayo's captains, and 60 of the soldiers were killed. The attack was so sudden, that the Zulus were not seen until they were within fifteen paces of the sentry. The soldiers of the camp were actually under arms, and in the laager at the time, but had scarcely even an opportunity of firing upon their assailants. It, fortunately, happened, however, that a small portion of the force had crossed to the opposite side of the swollen river, where they were able to maintain themselves until they could accomplish a safe retreat. It was in this part of the field that the operations of the defence, under the difficult circumstances in which he was placed by the repulse of the second column, were conducted by Colonel Evelyn Wood with such brilliant success, and with such important results upon the issue of the war. Colonel Pearson, with the southern column, consisting of 1,200 men, which had crossed the Tugela river, near its mouth, had reached the mission station of Etyowe,* some twenty-five miles from the frontier, when he heard of the reverse at Isandhlwana, and at once entrenched himself with earthworks in that position, and there remained upon his defence until he could be relieved by the advance of reinforcements. He was for some weeks entirely surrounded by an overwhelming force of Zulus, and had no other means of communicating with his base, except through the flashing of sun-signals, which was carried on with a small post established near the Tugela.

As soon as the news of the reverse at Isandhlwana were received in England, arrangements were promptly made for the dispatch of large reinforcements to Natal. By the close of the month of March, a sufficient number of these reinforcements had reached the colony to enable a flying column to be advanced to Etyowe, for the relief of Colonel Pearson's beleaguered forces. Lord Chelmsford's dispositions were sufficiently matured at the end of a month to enable him to cross the

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* See *Journal of the Society of Arts*, vol. xxiv., p. 165.

* Pronounced Eshowè.

Tugela with a well organised force of three regiments of infantry. A battle was fought on the 2nd of April, with 11,000 Zulus, who attacked Lord Chelmsford's camp in the early morning, and were speedily repulsed with severe loss. The relieving force then continued its advance to Etyowe, effected a junction with Colonel Pearson, after an isolation of ten weeks, and safely withdrew the beleaguered host and stores, establishing a fresh camp a few miles to the east of the old station in its place. A series of forts were at the same established along this line, to facilitate ulterior proceedings.

Another very marked passage of the war occurred simultaneously with the relief of the garrison at Etyowe. Colonel Wood, whose head quarters were at this time in the intrenched camp at Kambula, near the the north-western frontier of Zululand, and on the sources of the White Umvolosi River, had received orders from Lord Chelmsford to make a demonstration in force, to draw off the enemy's attention when he himself advanced upon Etyowe. Colonel Wood led 495 horsemen, in obedience to this instruction, against the stronghold of the Chief Umbelini, on the Zlobani Mountain, about twenty miles away towards the north-east. A large column of about 25,000 Zulus, who had been sent from Ulundi to attack Colonel Wood at Kambula, came upon him whilst engaged in scaling the heights of the Zlobani Mountain, and very nearly succeeded in cutting him off. He made good his retreat at the cost of some considerable loss, and in doing so drew the whole force of the Zulu column after him. On the 28th of March, the Zulus burst upon Kambula, and endeavoured to repeat the proceedings of their successful onslaught at Isandhlwana. Colonel Wood sustained a series of successive attacks within his entrenchments for about four hours, and then suddenly launched his horsemen upon them, entirely scattering the host, which lost about three thousand men altogether in the battle. This was, upon the whole, about the hardest struggle of the campaign. The Zulus returned again and again to the charge, and fought with great courage and resolution; Colonel Wood's killed, nevertheless, did not amount to more than twenty men—much less than he had suffered at Zlobane, where he had to sustain an overwhelming attack during his retreat from the mountain.

By the end of June, Lord Chelmsford's plans were ripe for his final advance against Ulundi. He crossed the Blood River from Utrecht, in the Transvaal, and was shortly afterwards joined by Colonel Wood's flying column, the two brigades making up together a force of 5,000 men, with 14 guns. Colonel Crealock was ordered to advance at the same time along the coast line from the neighbourhood of Etyowe, but was not able to effect his junction with Lord Chelmsford before the final conflict. An entrenched camp was established half way, on the Umlatosi River, on the 23rd June, and on the 3rd of July Lord Chelmsford encamped on the White Umvolosi River, in sight of the Royal Kraals of Unodwengo and Ulundi, which stand between the White and Black Umvolosi Rivers. It appears that at this time Cetywayo was desirous of coming to terms with his assailants, and that he actually sent off from his kraal one hundred white oxen as an expression of his wish. The animals, however, were intercepted, and forcibly driven back by one of Cetywayo's own regiments. A Dutch trader, Cornelius Vijn, who had been a prisoner in Zululand from the beginning of the war, and who had been turned to account upon frequent occasions as an interpreter of the communications that passed between Cetywayo and the English commanders, states that at the time when this occurred Cetywayo made an earnest appeal to his chiefs, in the course of which he said:—"At this moment the whites are on all sides, west, south, east, and north; and if tomorrow there should be a battle, you will all run away, and the whites will follow, and capture me only, and afterwards carry me away." The head men thereupon swore by the bones of their fathers, that, however the day might go, they would stay with him, and share his fate. It was, indeed, somewhat a matter of surprise that the regiments assembled at the royal kraal should have allowed themselves to be brought to stake the final issue of the war upon a decisive battle. But in all probability, this was one of the compensations for the loss at Isandhlwana. The success of the Zulu arms upon that occasion had generated a spark of foolhardy confidence in the leaders of the war party, and they still reckoned upon the numbers that they were able to bring into the field as sufficient to swallow up the small armaments of the white men. Upon the evening of the 3rd of July, a reconnaissance was made across the White Umvolosi by Lord Chelmsford's cavalry, who, in this way, led the Zulus to show their forces. This preliminary reconnaisance was accomplished at the loss of two or three men. At about this time Cetywayo, who evidently had considerable misgivings in his own mind as to the chances of the approaching conflict, disappeared from the scene. The battle of the following day was fought in the presence of Cornelius Vijn, and of several of Cetywayo's brothers; but the chief himself was not amongst them. He was already providing for his personal safety, under the contingency of defeat. On the morning of the 4th of July, Lord Chelmsford, leaving his waggons and heavy baggage in laager, crossed the Umvolosi river, and formed a hollow square between Unodwengo and Ulundi kraals, and in the immediate face of the enemy. The ammunition and native contingents were placed in the interior of the square, and a battery of artillery or Gatling guns were stationed at each corner. The Zulus, estimated at 20,000 men, at about half-past seven, advanced upon this square on every side, and endeavoured to enclose it in the usual way, by throwing forward horns. It was subsequently ascertained that the full strength of the regiments had been assembled at the royal kraals ten days before, and that it had then been determined not to attack the camp when entrenched, but to surround the troops when they moved forward upon the open plain, and whilst they were on the march. The Zulus advanced with great resolution and intrepidity, until they were within about seventy yards of the faces of the square, which were formed of the four ranks of infantry, the front rank kneeling. They were then greeted with a fire which served effectually to keep them from coming to closer quarters, or getting the chance of accomplishing a rush. As soon as they wavered under the influence of this fire, a squadron of lancers charged out upon them like a whirlwind, and the rout was complete. In half-an-hour after the attack upon the square, the Zulu force was in full retreat, and the cavalry entered Ulundi, which was found to be altogether deserted. It, and four other military kraals, were burned to the ground, and in the afternoon, Lord Chelmsford's force returned to the waggons, and the encampment of the previous day. The loss of the English on the occasion of this decisive victory was something of a different kind to that which was experienced in the surprise at Isandhlwana. It was returned at eleven killed, and twenty-nine wounded. Lord Chelmsford's own estimate of the loss of the Zulus was at least a thousand killed.

The victory at Ulundi was final and complete. All organised power of resistance was from that time broken. Sir Garnet Wolseley, immediately after the battle, assumed the command-in-chief, and he and Lord Chelmsford, within a few days, received, at Entonganeni, one of the highest and most central points in Zululand, the surrender and submission of all the leading chiefs, excepting Cetywayo, and Sirayo the delinquent who had been concerned in the forcible removal of the fugitive women from Natal territory.

The most surprising part of the narrative, however, still remains to be told. It was felt, from the instant of the victory at Ulundi, that, in order to effect any speedy settlement, it was of the utmost importance to secure the person of Cetywayo. Sir Garnet Wolseley turned his attention to this necessity as soon as he had assumed the command, and small armed parties were sent out in all directions to scour the country, and to endeavour to pick up the trail of the fugitive chief. Arrangements were at the same time made to intercept him, if he attempted to pass beyond the north-eastern frontier of Zululand, the only one open to his retreat. For nearly two months this search was persevered in, until the fugitive was at last tracked to a wild recess beyond the Black Umvolosi, in the heart of Zululand, and on the borders of the dense Ngome forest, in which it was from the first suspected he would endeavour to conceal himself. Now this search, it must be remembered, had to be carried on by very small parties of soldiers, moving through the strongholds of the people who had swallowed up a force of one thousand armed men at Isandhlwana. It was, nevertheless, successfully carried out, and Cetywayo was seized on the 27th of August, by a small detachment of mounted men, under the command of Major Marter, and then carried, under the care of a small escort, through the midst of the land to the sea coast, where he was safely embarked in the colonial steamer, *Natal*, for removal to Cape Town. There is no doubt that this service could only have been performed in this way under the tacit acquiescence of the Zulus themselves in Cetywayo's capture and removal. The cohesion of the Zulu rule had entirely collapsed under the shock which it had received at Ulundi. On the 26th of August, Major Marter and Captain Lord Gifford had both tracked the fugitive to his lair, approaching from opposite sides. Major Marter had under his immediate control two troops of the King's Dragoons, one company of Natal Natives, ten mounted irregulars, and four native guides. This party made its way stealthily up the side of a steep mountain ridge, and then Major Marter was led by his guides, crawling through thick grass, to the edge of a precipitous face of the mountain, and a small blockaded kraal of about twenty huts pointed out to him, in a semi-circular glade, 1,500 feet below, with an intimation that Cetywayo was there. The party had, in reality, been led round to the back of the kraal, so as effectually to cut off any further retreat into the mountain fastness. The soldiers were dismounted here, and had to lead their horses down the face of the mountain. The descent occupied about an hour and a quarter, the men mounted under the shelter of an intervening mound, about 500 yards from the kraal; and, it was then surrounded at a rush, and Cetywayo was found in the furthest hut of the kraal, and after some little delay, came out, under the threat of setting fire to the thatch, and gave himself up. He was then led, sometimes riding on a horse, and sometimes walking, back to Ulundi, which was reached on the 31st of August. He was there placed in an ambulance drawn by ten mules, and with a strong mounted escort, taken to Fort Durnford, on the coast of Zululand, about 26 miles from the mouth of the Tugela, which was reached after five days march, on the 4th of September. The captive was thence embarked in the steamer by means of a surf-boat, for the voyage to Cape Town, where he has since remained as a prisoner, under the charge of the Cape Government.

Cetywayo behaved with a considerable amount of dignity during the march to the coast, and the subsequent voyage to the Cape, which afforded him his first experience in sea-sickness. He was, of course, treated with as much consideration and kindness as it was possible to accord under the circumstances. During the time that was occupied by the captive's removal, Sir Garnet Wolseley continued to carry out his plans for the pacification of Zululand. It was finally arranged that the land should be placed under the charge of thirteen independent chiefs, who were to hold their districts at the hands of the British Government, upon the terms which they were required to accept as the conditions of their appointment. These conditions, substantially, were the recognition of the Zulu defeat, and the right of the Queen to impose her own terms thenceforth upon the Zulu people. It was further stipulated that the boundaries of each chief should be fixed by the British Government; that the old military system of organisation, and the restriction of marriage, according to Chaka's plan, should be abolished; that free intercourse with Natal and the Transvaal should be established; that the introduction of fire-arms and ammunition should be prevented; that capital punishment should in no case be inflicted without fair and open trial; that all fugitives from the British territory should be surrendered; that no war should be made without permission; that all arrangements for succession to the chieftainship should be amenable to British approval; that land is not to be sold or alienated; that all persons residing peacefully in the Zulu territory are to be allowed to remain; that all cases of dispute are to be referred to a resident officer appointed by the British Government; and that in any difficulties that may arise outside these provisions, the old laws of the land are to remain in force, and be administered by the chief.

It will be observed that the chief object of these conditions is the summary breaking up of the Zulu organisation, which had constituted Cetywayo's opportunity for offence, and the approximation of the state of the natives in Zululand to the condition which had grown up under the shield of British protection in the colony of Natal. There is nothing more certain than that the aboriginal inhabitants of this part of the African territory are not naturally of a warlike or predaceous character. This is convincingly shown in Sir Theophilus Shepstone's account of the state of the native tribes before Chaka's time.* The warlike spirit, which produced such dire results as Isandhlwana, was entirely due to the system of tribal aggression which was introduced by the genius of Chaka, which led to the establishment of the Zulu supremacy, and which has been, in reality, more or less resolutely maintained since his time. It is a very remarkable and significant fact, that throughout the Zulu conflict the natives residing in Natal remained perfectly loyal to the British Government, and were to some extent used in the conquest of Zululand. But for the circumstance of the unwarlike proclivities of the people when left to themselves, nothing would have been easier than to have put down Cetywayo by the Natal natives. The natives settled in Natal were more numerous than the subjects of Cetywayo at the outbreak of the war, and they were of the same race, and possessed of the same physical atrributes. But the Natal natives were a quiet, orderly, and inoffensive people, who had reverted to their primitive state, whilst the Zulus were an organised man-slaying machine, kept up to the highest pitch of offensive and aggressive power by the Chaka traditions and discipline administered by Cetywayo. It is for this reason that it has been held, and wisely held, that this discipline must cease, and that the paramount necessity is that the supreme chieftainship in Zululand shall be destroyed. It is for this reason that the attempt has been made to supersede the old centralised despotism by thirteen subordinate states or tribes. It has been urged by some who have contended for the absorption of the Zulus into the ranks of the neighbouring colony, that the new system of chieftainship will not work, and that the newly appointed chiefs will soon be found quarrelling and fighting amongst themselves. But, if this be the case, it is surely better for the interests of civilisation that they should fight amongst themselves, than that they should be in the position to pour 25,000 armed men, in a powerful military organisation, upon their unaggressive neighbours. The dignity with which Cetywayo has borne himself in his captivity, and the speciousness of some of his utterances, have suggested to some generous and kindly-disposed people the idea that he may have been somewhat hardly dealt with, and that it would only be consonant to the natural instincts of the British mind to restore him to his people and land, under some guarantee that he will, for the future, rule in a more merciful and less despotic spirit. It must be admitted that it is quite possible, if Cetywayo were sent back to Zululand, he would return in a sobered and softened spirit. Much that he has seen will have changed his views regarding the objects and powers of England, and he is at the same time growing an older as well as a wiser man. But there is one insuperable objection to his return which cannot be softened away or removed. His return would again, of necessity, raise the Zulu people into a self-contained and centrally administered kingdom, and with such a kingdom, the old aggressive organisation would assuredly be renewed. The mere fact of Cetywayo's return would favour this result. By the great majority of the people, who now accept their defeat, it would be held that his star, and Chaka's spirit, had in the end prevailed, and that not even the power of England could hold the captive in his bonds. Cetywayo himself, whatever he might desire, would be utterly unable to check the growth of this belief, at least amongst the young men. No more fatal policy, under any circumstance, could possibly be conceived than one which would undo the effects of the disruption of Zulu centralisation which has now so happily been brought about. It would be disastrous in the extreme for the people themselves. It would at once destroy the hope which has now opened out for their possible progress towards an orderly and civilised mode of life. To return Cetywayo to his old supremacy on the White Umvolosi River would be to prepare the way for another Isandhlwana at some future day. The apologists of Cetywayo, and the believers in his educatibility and honesty, must on no account close their eyes to this very possible issue of the measure which they advocate. No one who really knows the actual facts of recent events in Zulu history, can by any possibility doubt that such might be the result of such a policy.

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* See *Journal of the Society of Arts*, vol. xxiii, page 192.

On the other hand, it should not at the present time be overlooked that all that true humanity and philanthropy can require may be virtually secured without incurring so terrible a risk. It is quite possible to give Cetywayo all that his happiness and personal comfort require, without adding to the boon the facilities for renewed evil to himself, as well as to his people, which his return to Zululand would involve. The task which the authorities have to accomplish is to render the expatriation of the fallen chief as easy as may be to himself, and at the same time to prevent any renewal of the system of "personal rule," which has been fraught with such terrible results in Zululand. This is a task which may certainly be fulfilled by a judicious use of the opportunity which events have so recently placed in the hands of the authorities. With Zululand broken up into a series of separate and incoherent states, the orderly instincts and habits of the natives of Natal may be turned to account by the Natal Government, in confirming and establishing the supremacy of civilised rule, and in affording opportunity for the advance of the entire native community, although they would be so entirely incompetent to make any impression upon the power of an aggressive and barbarous despotism, armed to the teeth, wielded by a single unscrupulous and irresponsible hand, and nerved by the ruthless and unsparing traditions of Chaka. In a dispatch of Sir Bartle Frere, at that time acting as Supreme Commissioner in South Africa, dated from Pretoria, on the 18th of April, 1879, and therefore nearly three months before the victory at Ulundi, attention was very forcibly drawn to the circumstance, then proved by events, that the Zulus were at that time a military power able to destroy a regiment of British infantry accompanied by artillery, and to shut up a brigade six times as strong as the ordinary garrison of Natal; with an organisation that avowed foreign conquest and bloodshed as a necessary part of its existence, and so surrounded by British territory; that it could only carry out its avowed spear baptising proclivities upon British subjects, or British allies. Sir Bartle also insisted very strongly upon the terrible fact that in their barbarous warfare they show no quarter, and make no prisoners; and also upon the circumstance that they have really no proper claim to the territory which they aspire to hold, having no title to anything saving a small and remote fragment of the land near Delagoa Bay, the original seat of the tribe, other than that which they have acquired by devastation and massacre; and, that it is above all things in the interests of the Zulus themselves, that they should not be left to the fearful fate which the late reign of terror entailed. Sir Bartle also affirmed his own conviction that the people themselves are everything that can be desired as material for a fine race of men, with all the capacities for forming a happy and civilised community, where law, order, and right may be made to prevail, in place of ruthless despotism, and that this desirable consummation needs, as a preliminary step, only the breaking down of the military system of Cetywayo. This really is the view that the British authorities adopted at the termination of the war, and which is virtually held by the Government of Natal, and by the very large majority of the colonists whose home is in that dependency. In a recent communication to the Colonial Institute, in advocating this view, Mr. Saunders, who is the representative of one of the coast districts of the colony in the Legislative Council, with some force urged, in reply to one of the advocates who had been pleading for the restoration of Cetywayo as an experiment, that the first step in any such trial should be that the advocates of this policy should go themselves and live upon the exposed frontier of the colony, as a practical proof of their own confidence in the success of the expedient. In a recent debate in the House of Commons, Sir Henry Holland, in alluding to the character which Cetywayo has given himself for a humane disposition and good intentions, and to the favourable impression which he has made upon many kindly people, very shrewdly remarked that, "Humanity in imprisonment is quite consistent with cruelty in power." This really is the correct apprehension of the truth. When Sir Theophilus (then Mr.) Shepstone went into Zululand, in 1861, to persuade Umpanda to make a formal acknowledgment of Cetywayo's successor, Cetywayo came to the council of the king and the old men, with some thousands of turbulent young followers, all secretly armed with their assegais, and took the lead in a riotous demand for the restoration of certain refugees in Natal who were obnoxious to him. The danger of this meeting was only turned aside by the coolness and self-possession of Sir Theophilus Shepstone. But when he was indignantly hastening away from the perilous position the following morning, Cetywayo stood alone in his path, with a present of elephant's tusks, and assured Sir Theophilus that he was the humblest, and gentlest, and most obedient of his children.* At the present time Cetywayo is again making an offer of his tusks. But the all-important question is, what would he be doing if he were again on the White Umvolosi River, with his thousands of impulsive young warriors around him.

It will be remembered that in his communication to the Society of Arts, in January, 1878,† Mr. Fynney gave an interesting sketch of Cetywayo, drawn from his own personal acquaintance with the chief shortly before the war. The portrait thus sketched is quite in accordance with the subsequent observations of those who came across him in the early days of his captivity. The special war correspondent of one of the Natal newspapers, who was at the head-quarters camp when the captive was brought in by Major Marter, gave the following description of his appearance at that time:—

> "The king, who is ringed" (that is, who has the ordinary head-ring of the adult Kafir), "wore a long damask table-cloth thrown over his shoulders. He is a fine, stoutly-made man, of about 45, with an intelligent face, high forehead, and fairly good features. He has well-shaped hands and feet, and long nails, of which he seemed very proud. He walked very erect and slowly, and looked every inch a king. He is certainly one of the best-looking Kafirs that I have ever seen."

Another witness who had the opportunity of observing him on the march, said of him:—

> "Whilst squatted, sipping his 'squareface' (that is, Hollands gin, taken from the Dutch square bottle), with a very gorgeous, rainbow-hued rug thrown over his shoulders, which he exchanged at night for the damask tablecloth worn during the heat of the day, Cetywayo would enter most affably into conversation,

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* See "The Zulus and Boers," page 47.

† See *Journal of the Society of Arts*, vol. xxvi., page 119.

behaving at all times with perfect courtesy and good breeding, being most particular not to interrupt any one who was speaking, and evincing considerable annoyance at the way some of the officers repeated the same question over and over again, often asking another question in the middle of the king's answer to a former one."

He conversed with apparent freedom about the incidents of the war, but was reticent upon some particular points. It was evident that he had taken the keenest interest in everything that had taken place, and even recollected the different officers killed in the various actions, though of course he was not always able to give their names. His observations often manifested that he is possessed of a considerable sense of humour. On the first morning at sea, when there was no land in sight, after looking round he held up his hands in intense astonishment, although he did not generally permit himself to manifest surprise at anything.

The high estimates that have been formed of the physical capacities and characteristics of the Zulu race are signally confirmed, even by the terrible history to the later incidents of which attention has been here drawn. In a communication contributed to the Society of Arts some time since,* some allusion was made to the remarkable prominence of the Zulu forehead. The author is now in the position to offer a further confirmation of this peculiarity. Until very recently, the splendid collection of human skulls in the Museum of the Royal College of Surgeons was destitute of any satisfactory specimens of the Zulu race, and Professor Flower, the distinguished curator of this ethnological shrine, asked the author to assist him in getting this deficiency supplied. The author has, in consequence, managed to place in Professor Flower's hands four skulls, which were procured from the field of Isandhlwana, and which, as relics of the battle, are undoubtedly genuine specimens of the Zulu type of cranial organisation. They were taken from the spot were one of the well-known Zulu regiments made its onslaught, and were evidently the skulls of four of the young warriors who had fallen in the conflict. One of them is perforated on both sides of the skull by a conical rifle bullet, which had passed clean through the head. These four skulls have all a common character, but the finest of them is chiefly remarkable for the very large brain-space which it exhibits. Professor Flower states that the cerebral cavity in this skull is only exceeded by two or three skulls in the collection, and that it is itself considerably in excess of the dimensions presented in the average European skull.

It is a curious circumstance that, with apparently so capacious a brain, this remarkable race of men should be so destitute of the power of making a civilisation for itself. The native population of Natal resides principally in districts that have been set apart for their use by the Government, and there they dwell very much in the state in which they lived before the invasion of Chaka—a state which has been so graphically painted by Sir Theophilus Shepstone, in the communication which was read in this room seven years ago.* They have reverted to their original condition, dwelling in these locations in the bee-hive-shaped straw hut, almost without clothes, and with no other furniture than the straw mat, the wooden pillow, a few grass and wooden milk bowls and beer pots, and wooden spoons; and this they continue to do, notwithstanding the examples of the comforts and advantages of civilised life which they have everywhere around them, and under their eyes, in the neighbouring homesteads of the white settlers. This is an anomaly for which no satisfactory explanation can be furnished. There is, no doubt, a tendency in the Kafir race to revert to the habits of barbarous life, even after they have been drawn into the surface observances of a more civilised existence. This must not be forgotten in any anticipation that is formed of the results that are to be looked for in the settlement of the Zulu Kafir race after the disruption of its military system, and the destruction of its barbarous organisation. The task is, in all probability, one that will require both patience and perseverance. The old, cruel habits and traditions can only be gradually replaced by the healthier and higher craving for the blessings and advantages of a peaceful and merciful rule. But this is a consummation which will assuredly be reached with the progress of time, when the barbarous habits have been repressed, and as new generations succeed to the earlier ones. It is, at any rate, a task that must be accomplished if the civilised race is to remain in these South African lands, and it is the contrast which is already exhibited between the Zulu Kafirs in Natal, and the Zulu Kafirs who are but just escaping from Cetywayo's cruel rule, that gives the assurance the work will certainly be done, and that the destruction of the old Zulu system of "baptism of spears," and of the "killing of men," is an important step towards the accomplishment of the beneficial change. It is in this sense that the colonists, who have recently been engaged in the life and death conflict with the arch representative of the old system, are so averse to any experiment which involves his restoration to influence and power.

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* *Journal of the Society of Arts*, vol. xxiii., p. 198.

* See *Journal of the Society of Arts*, vol. xxiii., page 192.

The author would not willingly conclude these remarks on recent passages in Zulu Kafir history without recalling the attention of the meeting to the notable testimony which Sir Bartle Frere has borne to the capabilities of this interesting race, and which has already appeared in the *Journal* of the Society.* One passage towards the close of the communication which he made upon that occasion is so important and pertinent, that it deserves to be quoted again and again. After alluding in a few eloquent words to the past history of the native tribes, he says:—

> "I have known men of these native races endowed with natural capabilities in no way inferior to the average of those who make their mark in intellectual or political careers, even amongst ourselves. These are their capabilities. What is needed for their development? Nothing, I believe, but settled order and government—of our modern European civilised type—a government which can frame laws, and enforce them, which can defend life and property, and enable its citizens, as long as they obey the law, to prosper and advance in civilisation and happiness, each according to his own individual qualities."

But this is exactly, it will be observed, what Cetywayo's system of military organisation and personal government can in no sense pretend to do.

It is with great satisfaction, therefore, that all true friends of this interesting people must have hailed Mr. Gladstone's recent assurance from his place in Parliament, that, in the present contingency of Zulu Kafir affairs, the peace and welfare of the country must be the dominant consideration of her Majesty's Government; and that Cetywayo's "baptism of spears," and summary mode of making his people listen by "killing them," will not be restored to Zululand until that Government have well weighed all the actual circumstances of the case, in the face of the obvious consideration that if Cetywayo's return was not an effective cause of pacification, there is the moral certainty that it would be a "very serious cause of renewed disturbance and bloodshed."

[The paper was illustrated by a series of photographs shown on the screen by means of the oxy-hydrogen lantern.]

The CHAIRMAN proposed a vote of thanks to Dr. Mann for his interesting paper, and for the series of illustrations he had given. Considerable trouble had been expended by him in getting the pictures prepared for the meeting, and his labour of love in that respect had extended over many months.

Dr. MANN thanked the meeting for their attention, and apologised for having occupied so much of their time. His justification must be the interesting nature of the subject.

INDIAN SECTION.

Friday, June 2; ANDREW CASSELS, member of Council, in the chair. The paper read was —"The Production of Tea, Cinchona, Rhea, and Wild Silks in India." By J. R. ROYLE.

[This paper will be printed in the next number of the *Journal*.]

Miscellaneous.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The fifth and last General Report of the School, dated Easter, 1882, has just been issued. After noticing the changes in the staff of the School, the Committtee of Management report as follows:—

Scholars and Private Students.—At the beginning of the present year, a considerable change took place in the body of the students. The period of five years for which the school was originally designed to work on a voluntary basis, had just expired, and thirty-three of the scholars retired from the school with certificates of merit, according to their respective qualifications. With very few exceptions, these late scholars forthwith entered upon the duties of the profession for which they had been trained at the school. Seven private students also left at the same time.

In the hope that the Royal College of Music, which was being actively promoted by the Prince of Wales and a distinguished body of gentlemen whom H.R.H. had associated with himself, might shortly be organised and ready for work, a special effort was made to obtain the means of keeping the school going for an additional year, viz., from Easter, 1881, to Easter, 1882, on the same voluntary basis, and resulted in the endowment of eighty-three scholarships of £40 a year each.

Of these scholarships, fifty-four were given to former scholars, and nine to former private students,

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*See *Journal of the Society of Arts*, vol. xxix, p. 212.

without competition; and twenty were put up for public competition, and were competed for. The eighty-three scholars thus elected consisted of twenty-one males and sixty-two females. Ten private students also were admitted during the year, bringing up the body of students to a total of ninety-three.

Attendance, Conduct, and Studies.—The attendance of the scholars, save in cases of sickness, has been regular and punctual, and their general behaviour very satisfactory. The instruments and subjects of study are, of course, substantially the same as they were at the time of the issue of the last report. Thirty students have cultivated the piano as their principal subject of study; thirty-one, singing; fifteen, the violin; five, the organ; one, the violoncello, and one, the flute. The pianists take singing, violin, organ, clarionet, oboe, or violoncello for their second studies; while the vocalists, violonists, and organists are compelled to study the piano. All the students continue to attend the harmony and choral classes; the vocalists attend the Italian classes; and all those who are competent for it, have instruction in counterpoint and composition. The orchestral class has remained under the direction of Mr. F. H. Cowen; but during his recent absence in Vienna, the practices have been conducted by Dr. Bridge. It embraces all those students who play upon orchestral instruments, and meets for practice two hours per week.

Students' Concerts.—During the year two series of students' concerts—one of four, and one of five concerts—have been given in the arena of the Royal Albert Hall. About 1,000 tickets of admission have been issued gratuitously to the friends of the School, the members of the press, and the public generally for each performance, and the concerts, without exception, have been attended by numerous and appreciative audiences. The first series was given in the months of June and July, 1881. The second series in the months of February and March, 1882.

Respecting the closing of the School, the Committee report:—

With this Examination the work of the term and of the School, came to a conclusion. The question of closing the School, to make way for the Royal College of Music, had been discussed and settled at a meeting of the Committee of Management held on the 13th March, 1882. At the close of the debate, it was unanimously resolved:—

1. That the National Training School for Music should be closed at the end of the present term, on the 1st April.

2. That His Royal Highness the President should be requested to write a letter to the Prince of Wales, informing his Royal Highness of the closing of the National Training School for Music, and respectfully requesting him to accept the balance of its funds which shall be in hand at the end of the present term, towards the endowment fund of the Royal College of Music, to be established under the auspices of His Royal Highness.

3. That the Prince of Wales should also be requested to receive the furniture, fittings, instruments, music, records, documents, and all other possessions of the School, for the use of the said College.

4. That H.R.H. the President should further take H.R.H. the Prince of Wales's pleasure as to the future custody of the building, munificently presented by Mr. Freake to the Prince of Wales, in which the authorities of the School have carried on their work for the past six years.

The report concludes with a statement of the results of the work of the school:—

Since the opening of the school on the 17th May, 1876, there have been admitted 180 students, viz., 49 males, and 131 females. Of these, 152 have held free scholarships, and 28 have been private students who have paid their own fees. Perhaps it ought to be stated here, that the only differences between these two classes of students are these:—Private ustdents pay for their own education, and are admitted after a test examination; scholars are provided with their education free of expense to themselves, and must successfully pass a competitive examination before admission. In all other respects they are alike. They enjoy the same privileges, attend the same classes, are taught by the same professors, and are subject to the same discipline.

Of the scholars, 110 are either earning their own living, or largely contributing thereto, by the profession for which they have been prepared at the school. No less than thirty of them are artists of recognised merit, who have won for themselves distinguished positions in the musical world as composers, public singers, pianists, organists, and violinists.

It should also be mentioned that the Mendelssohn scholarship has been recently unconditionally awarded to Mr. d'Albert in recognition of his genius and acquirements.

Eight of these former scholars are music mistresses in high schools; one is a professor in this school; another is a professor in the Guildhall School of Music; one is the conductor of Mr. Henry Leslie's Musical Association at Oswestry; one is a primo basso in one of the opera houses in Italy; three are singing in operettas in London; and a large proportion of the remainder of them are filling positions of more or less importance as conductors of orchestras, as organists and choir masters, as teachers of music and occasional solo performers in London and the provinces; two of them gained fellowships, and four associateships, at the College of Organists while they were still students.

Of the remaining students, four have retired from their scholarships to be married; one has lately died. Several of the private students, and six of those who have held scholarships, were either never destined for the profession, or have, for private reasons, given up the intention of making music their calling in life; a few, though accomplished musicians and performers, are still too young either for the responsibilities of a public career, or to undertake the arduous and important duties of teaching; and a few more have been under instruction too brief a time to acquire the necessary qualifications for taking up the duties of their profession.

MANUFACTURE OF WINE FROM RAISINS IN FRANCE.

Consul Taylor, of Marseilles, states, in his last report, that since the first appearance of the phylloxera in the vineyards of France, there has been a steady diminution in the quality of wine produced, and in a tabular statement, he shows that the quantity produced in 1880 amounted to 29,677,472 hectolitres, against 56,406,363 hectolitres in 1877, and this year itself was, by several millions of hectolitres, less than the average of previous years. To make up for this deficiency, a novel product, made out of dried raisins, was introduced. In the year 1880, at the port of Marseilles alone, 36,394,527 kilogrammes of raisins and dried currants were imported, and according to Consul Taylor, all the raisins or currants coming from the East, viz., over 30,000,000 kilogrammes, were used in the preparation of this raisin wine ; and when it is taken into consideration that 100 kilogrammes of raisins are capable of yielding 325 litres of wine, an idea may be formed of the quantities of wine of this description which have been manufactured at Marseilles alone. It appears that the process employed in the manufacture of wine out of raisins does not differ in any material degree from that in the manufacture of ordinary grape wines. It is assumed that the grape in going through the process of desiccation loses none of its original elements, save the water which enters into and forms about 80 per cent. of its composition. By restoring this lost water, the raisin becomes capable of yielding the same liquor as before it was dried. The raisins are carefully cleansed and freed from all impurities, and then allowed to soak in a tub with a quantity of water equal to the quantity of wine that is to be manufactured, distilled water, when possible, being used. The time during which the raisin is to soak is forty-eight to fifty hours in winter, and about forty hours in summer. It is frequently and carefully stirred, and is sufficiently soaked when it has resumed the appearance of a fresh grape, and when, being pressed between the forefinger and thumb, it breaks with a report. This being done, the usual course for the preparation of wine is strictly followed, a little more care only being required. The raisin is crushed in the usual way, and placed in the fermenting tub, being well stirred at the beginning, in order to separate the grains from each other, and to commence a regular fermentation. The "must" is kept at a temperature of 15° Centigrade, and the cellar at an invariable temperature of from 15° to 20° Centigrade. When properly conducted, the fermentation is completed in twelve days, and the raisin wine is then ready to be drawn and put into casks, the usual process of sulphurising, clarifying, &c., being followed. The wine is then claimed to be composed of exactly the same principles as fresh grape wine, but differs from it by its colour, as it is invariably white, or at the best, straw-coloured. The wine produced in the Bouches du Rhône district is dark red, strongly alcholised wine, and accordingly the raisin wine is coloured by artificial means, and frequetly with deleterious compounds, some of the dyeing stuffs used for the purpose being, it is said, extremely injurious to health. Consul Taylor states that scarcely a week passes at Marseilles without large quantity of wine thus adulterated being condemned by the local authorities and poured out into the sea. The raisin wine is also largely used in its natural state, that is to say, without being coloured by artificial means, by simply mixing it with red wines that are so deep in colour that the addition of a certain quantity of raisin wine improves both. The central administration, which at first denounced the manufacture of raisin wine in France as an offence, and made the manufacturer liable to a prosecution for falsification of wine, has now, and for some time, entirely changed its view of the matter. All the hindrances opposed in the beginning to this branch of industry have been removed, and at the present time there is no distinction made between the raisin and the grape wine, both productions being submitted to the same charges and duties, and recorded under the snme headings in all the official books and returns.

Correspondence.

BARFF'S BORO-GLYCERIDE.

I wish to call the attention of those interested in this subject, and, indeed, of Professor Barff himself, to a paper on boric ethers, published by MM. Schiff and Bechi, in the *Comptes Rendus* vol. lxii, p. 297, in which Mr. Barff's "Boro-glyceride" is detailed at length, and in physical properties, and chemical constitution, fully agrees with the Professor's description. . . . . "La borate glycerique (the boro-glyceride) form une masse vitreuse jaune, très higroscopique. . . . . qui se décompose facilement avec l'eau chaude." And again, in Watt's "Dictionary of Chemistry," 1st supplementary volume, p. 364, "Glyceric-borate" (the boro-glyceride) "dissolves without alteration in a small quantity of water, but on heating, the dense, somewhat acid solution coagulates to a dense mass, and acquires a sweet taste, being, in fact, resolved into boric hydrate (boracic acid) and glycerine." (Of course, in such dilute solutions as would be necessary for antiseptic baths, the liquid would not be apparently dense, nor would there be any distinctly visible coagulation on heating.) When discussing the means of applying his invention, Professor Barff invariably heats the solution or baths of his compound, and I shall again quote from the *Journal*. . . . . . . "If milk were concentrated in this country, and heated with the boro-glyceride, carriage would be saved, and the milk might be kept good. . . . ." In the Rev. Mr. Dobson's experiments, where beer was treated, presumably in the cold, we hear of fungoid growths having been developed. This is significant, for fungus points to failure, and this Mr. Dobson attributes to the severity of the experiments. It would, therefore, seem that Mr. Barff's compound, which he was so desirous of not decomposing, is only efficacious when, by the action of heat, he splits it up into the two constituent bodies—boracic acid and glycerine; both antiseptics I grant, but both vastly inferior to other more modern ones; for indeed the Professor himself declares the one ineffective by itself, and the other he condemns as objectionable and unsuccessful. As for the unwholesomeness of salicylic acid, especially its use in brewing, and its condemnation in France, mentioned by Dr. Graham during the discussion, I regard this solely as an unwholesomeness consequent on the employment of all antiseptics when they are used in excess and unwisely; and I take its condemnation in France as a proof that that country is not yet aware of the powerful antiseptic action it possesses, and what a long way a little of it goes.

EDWD. R. MORITZ, PH.D.; F.C.S.

72, Chancery-lane, W.C.

[The original paragraph from the *Journal* quoted above contained a misprint, and should have stood, "If milk were concentrated in this country and treated with the boroglyceride." The correct word is *treated*, not *heated*.—ED.]

Obituary.

DUGALD CAMPBELL.—Mr. Dugald Campbell, an analytical chemist of long standing, and a member of the Society of Arts since 1849, died at his house in Holland-road, Kensington, on the 12th May, aged 64. Mr. Campbell went to Australia in his early youth, and on his return to England commenced the study of chemistry, under Thomas Graham, afterwards Master of the Mint, but then Professor of Chemistry at University College. He paid particular attention to the questions of water supply and the utilisation of sewage; and early in his career, assisted Professor Clark, of Aberdeen, in his experiments in the process of water purification. He published in 1869, a "Practical Text Book of Inorganic Chemistry," and read numerous papers before the Chemical Society. He also prepared several of the volumes of the Abridgments of Patents.

COLONEL JOHN THOMAS SMITH, R.E., F.R.S.—Colonel Smith, who was for many years Master of the Mint at Madras, and afterwards of that at Calcutta, died on the 14th May. In 1826, he went to India as an officer of Engineers, and there made a series of investigations in optics. Subsequently, he translated Vicat's work on "Limes and Cements," adding to it the results of independent investigation. He was elected a Fellow of the Royal Society in 1837, and a member of the Society of Arts in 1865. Upon his retirement from the Corps of Engineers, Colonel Smith was for some time consulting engineer to various Indian irrigation companies, and eventually chairman of the Madras Railway Company. Colonel Smith was the author of several scientific works, and he received the Society of Arts' silver medal, for his paper on "The Depreciation of Silver," read before the Society in 1878.

General Notes.

ROYAL CORNWALL POLYTECHNIC SOCIETY.—This Society, which was instituted in 1833, will open a Jubilee Exhibition at Falmouth, on the 5th of September next. The committee is anxious to make it representative of the progress of the past half-century in science and art, especially as bearing on mining enterprise, but also in relation to naval architecture and fishing, meteorology, photography, natural history, and statistics, as well as the fine arts, pure and applied, more especially in connection with the county of Cornwall.

MANUFACTURE OF STEEL PENS.—Steel used for making pens reaches the factory in sheets about 2 ft. long by 1 ft. 3 in. wide, and 0·004 inch thick. They are cut into bands of different widths, according to the dimensions of the pen required, the most usual widths being 2, 2½, and 3 inches. The bands are then heated in an iron box, and annealed, when they are passed on to the rolls and reduced to the desired thickness of the finished pen, thus being transformed into ribands of great delicacy, about four leet long. The blanks are then stamped out from the ribands by a punching machine, the tool of which has the form of the pen required. The blanks leave the die at the lower part of the machine, and fall into a drawer, with the points already formed. They are then punched with the small hole, which terminates the slit, and prevents it from extending, and afterwards, raised to a cherry-red heat in sheet-iron boxes. The blanks are then curved between two dies, the concave one fixed, and the convex brought down upon it by mechanism. The pens, now finished, as regards their form, are hardened by being plunged, hot, into oil, when they are as brittle as glass. After cleansing by being placed in a revolving barrel with sawdust, they are tempered in a hollow cylinder of sheet-iron, which revolves over a coke fire after the manner of a coffee-roaster. The cylinder is open at one end, and while it is being turned, a workman throws in twenty-five gross of pens at a time, and watches carefully the effect of the heat on the colour of the pens. When they assume a fine blue tint, he pours the pens into a large metal basin, separating them one from another, to facilitate the cooling. After this process, which requires great skill and experience, comes the polishing, which is effected in receptacles containing a mixture of fine sand and hydrochloric acid, and made to revolve. This operation lasts twenty-four hours, and gives the pens a steel-grey tint. The end of the pen, between the hole and the point, is then ground with an emery-wheel revolving very rapidly. There only now remains to split the pens, which is the most important operation, being performed by a kind of shears. The lower blade is fixed, and the upper one comes down, with a rapid motion, slightly below the edge of the fixed blade. To give perfect smoothness to the slit, and at the same time make the pens bright, they are subjected to the operation of burnishing by being placed in a revolving barrel almost entirely filled with box-wood sawdust.—*Chronique Industrielle.*

SCARCITY OF IVORY.—It is stated in the *Engineer*, that on May 15th there were only 127½ tons of ivory in stock in London. The smallest stock for many years was in March last, viz., 107½ tons; the largest in July, 1878, viz., 301¼ tons. At present, there are probably in dealers' private warehouses about 40 tons, while at one time the private dealers used to hold over 100 tons in their own warehouses. Eight ivory cutters in Sheffield cut up £124,000 worth of tusks in a year, and the two largest cutlery houses add a value of £16,000 each per annum to that total. One-fourth of all the ivory imported into England is used in Sheffield for cutlery hafting, and other purposes. It does not appear that any really satisfactory substitute for ivory has yet been produced. The material known under various names, but generally called celluloid, has not served more than a limited purpose. The same may be said of vegetable ivory. None of these things will take the peculiar polish of ivory. An enormous trade could be done in a really satisfactory substitute for the elephant's tusks.

CONTINUOUS SAW FOR STONE.—Mr. P. Gay has invented an endless band saw, which consists of a steel wire rope passing over two pulleys. It not only receives a rapid rotary motion, but also one of twisting upon itself in such a way that the strands of steel wire cut their way into the stone, and clear their passage. The work done is said to be from 25 to 30 times that which can be done by hand in the same time.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 12...Sanitary Assurance Association (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. A Public Meeting. Mr. H. Rutherford, "Sanitary Assurance from a Householder's Point of View."

Royal Geographical, University of London, Burlington-gardens, W., 8.30 p.m. Rev. W. Deans Cowan, "Explorations in South-Central Madagascar."

TUESDAY, June 13...Gas Institute, 25, Great George-street, Westminster, S.W., 10 a.m. Annual General Meeting. Inaugural Address by the President. Presentation of Birmingham Medal to George T. Livesey. Reading of Papers and Communications. 2 p.m., Reading of Papers and Discussion continued.

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Institution, 4, St. Martin's-place, W.C. 1. Rev. S. Mather, "Nepotism in Travancore." 2. Mr. G. W. Parker, "The Laws of Madagascar." 3. Mr. G. H. Kinahan, "Cummer, Co. Wexford."

Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. George Baden-Powell, "Imperial Defence in Our Time."

WEDNESDAY, JUNE 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Conversazione at the South Kensington Museum.

Ladies' Sanitary Association (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m. Distribution of Prizes by H.R.H. the Duchess of Teck.

Royal United Service Institute, Whitehall-yard, 3 p.m. Vice-Admiral Selwyn, "Notes on Hydraulic Propulsion."

Microscopical, King's College, W.C., 8 p.m.

Gas Institute, 25, Great George-street, S.W., 10 p.m Reading of Papers and Discussion continued.

THURSDAY, JUNE 15...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. T. T. Dyer, "Caoutchouc-yielding Plants of Malaga." 2. Messrs. W. Pollock and G. J. Romanes, "Sense of Smell in Actinia." 3. Messrs. Berkeley and Broome, "Fungi of Australia." 4. Mr. J. G. Otto Tepper, "Tasmanian Plants in South Australia." 5. Mr. R. McLachlan, "A Marine Caddis Fly from New Zealand." 6. Prof. E. Ray Lankester, "Habits of Scorpions." 7. Prof. Duncan, "The Genus Pleurochinus."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for the Election of Fellows. 2. Mr. C. E. Groves, "Note on the Preparation of amido-β-naphthol and β-naphtha-quinone." 3. Mr. J. J. Hummel and Mr. A. G. Perkin, "Some New Compounds of Brazilein and Hæmatein." 4. Mr. R. Warington, "The Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Salts." (Part II.)

Victoria Institute (at the HOUSE OF THE SOCIETY OF ARTS), W.C., 8 p.m. Annual Meeting.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W. Morning Meeting.

Numismatic, 4, St. Martin's-place, W., 7 p.m. Annual Meeting.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Gas Institute, 25, Great George-street, S.W., 10 a.m. Reading of Papers and Discussion continued.

FRIDAY, JUNE 16....Royal United Service Institute, Whitehall-yard, 3 p.m. Lieut. Charles Campbell, R.N., "The Interior Economy of a Man of War—Past, Present, and Future."

Philological, University College, W.C., 8 p.m., Prof. Postgate, "Sum Latin and Greek Etymologies."

SATURDAY, JUNE 17....Geologists' Association, University-College, W.C. Excursions to Rickmansworth.

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FRIDAY, JUNE 16, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Twenty-eighth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Members, will be held, in accordance with the Bye-laws, on Wednesday, the 28th of June, at 4 p.m.

(By order of the Council)
H. Trueman Wood,
Secretary.

ALBERT MEDAL.

The Council of the Society of Arts have awarded the Albert Medal of the Society of the present year to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., for "his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine making, silk production, and agriculture, have been greatly benefited."

MEDALS.

The Council have awarded the Society's Silver Medals to the following readers of papers during the Session 1881-2:—

To Professor Silvanus Thompson, D.Sc,, for his paper on "Storage of Electricity."

To J. Emerson Dowson, for his paper on "The Production and Use of Gas for Purposes of Heating and Motive Power."

To Colonel G. F. Pearson, for his paper on "The Teaching of Forestry."

To Professor Barff, M.A., for his paper on "A New Antiseptic Compound, and its Application to the Preservation of Food."

To Spencer Walpole, for his paper on "The Fish Supply of London."

To George F. Deacon, for his paper on "The Constant Supply and Waste of Water."

To Captain Richard F. Burton, for his paper on "Gold on the Gold Coast."

To R. Warington, for his paper on "Some Practical Aspects of Recent Investigation in Nitrification."

To S. G. Thomas and Percy C. Gilchrist, for their paper on the "Manufacture of Steel from Phosphoric Pig-iron."

To Alexander M. Chance, for his paper on "The Recovery of Sulphur from Alkali Waste by Schaffner's Process, a record of recent results."

To James Mylne, for his paper on "Experiences of an European Zemindar (landholder) in Behar."

Thanks was voted to the following Members of Council for the papers they had read:—

To Captain Douglas Galton, C.B., F.RS., for his paper on "The American System of Heating Towns by Steam."

To W. H. Preece, F.R.S., for his paper on "Electric Lighting at the Paris Electrical Exhibition."

To Lieut.-Colonel C. E. Webber, R. E., for his paper on "Telephonic Communication."

To Sir Rutherford Alcock, K.C.B., for his paper on "The Opium Trade."

EXHIBITION OF MODERN ENGLISH POTTERY.

The Exhibition was opened on Wednesday, 24th ult., and will remain open (every day from 10 to 4, Saturday 10 to 2) until Friday, 30th inst. Members of the Society are admitted on signing their names, and can admit friends either by use of the tickets supplied for the evening meetings and lectures, or of their visiting cards.

A catalogue of the Exhibition was given in the number of the *Journal* for May 26th.

Proceedings of the Society

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 14th June.

The Galleries containing the Raphael Cartoons, the Sheepshanks Collection, the Wm. Smith Collection of Water Colour Drawings, the Dyce and Forster Pictures, the Collection of Paintings lent by the Trustees of the late Rev. Pryce Owen, and "The Chantrey Bequest," as well as the Courts and Corridors of the Ground Floors were open. The Reception was held in the Architectural Court, by Sir FREDERICK BRAMWELL, F.R.S., Chairman, assisted by the following Vice-Presidents and Members of the Council:—Mr. Andrew Cassels, Lord Alfred S. Churchill, Mr. B. Francis Cobb, Admiral Sir E. Inglefield, C.B., F.R.S., Sir Philip Cunliffe Owen, K.C.M.G., C.B., Lieut.-Col. Donnelly, Mr. W. H. Perkin, F.R.S., Mr. Loftus Perkins, Mr. W. H. Preece, F.R.S., and Mr. R. Rawlinson, C.B.

Promenade Concerts were given by the Band of the First Life Guards in the North Court, and by the Hungarian Band in the Lord President's Court, the following being the programmes of music performed.

The Band of the First Life Guards (Conductor, W. v. d. Heuvel):—

1.	Overture	"Ruy Blas"	*Mendelssohn.*
2.	Valse	"Je t'aime"	*Waldteufel.*
3.	Selection	"Patience"	*A. Sullivan.*
4.	Polka	"Bonne Bouche"	*Waldteufel.*
5.	Chorus	"Der Fliegende Holländer"	*Wagner.*
6.	Valse	"My Queen"	*Bucalossi.*
7.	Song	"The Lost Chord"	*A. Sullivan.*
8.	Selection	"La Mascotte"	*Audran.*
9.	Valse (Masonic)	"Grand Lodge"	*C. Godfrey.*
10.	Selection	"Boccaccio"	*Suppé.*
11.	Polka	"Glocken"	*Arranged by W. v. d. Heuvel.*

The Hungarian Band (Leader, Berges Lagos):—

1.	Ungarische Overture		*Elenbogen.*
2.	Isteni		*Csardas.*
3.	Spizentuch der Königin		*Strauss.*
4.	Magyar Ábrand		*Berkes Lagos.*
5.	Nagzvillag		*Emlek.*
6.	Ungarische Lieder		*Piros Piros.*
8.	Cimbal Solo and Duet.		Paul and Joseph Pinter.
8.	Walzer	"La Berceuse"	*Waldteufel.*
9.	Polka	"Zücker"	*Farbach.*
10.	Waltzer	"Centrum"	*Struss.*
11.	Csak egg kis Layvan a Vilagon		*Nimet.*
12.	Ungarische Melodi		*Berkes Lagos.*

A Concert, consisting of Glees, &c., was given at intervals, in the Lecture Theatre, by the Royal Criterion Handbell Ringers and Glee Singers, under the direction of Mr Harry Tipper:—

Bells—"Marche aux Flambeaux."

Part Song	"Hail to the Chief"	*Bishop.*
Chorus	"Carnovale"	*Rossini.*
Part Song	"May Day"	*Müller.*
Chorus	"Comrades' Song of Hope"	*Adolphe Adam.*

Bells—"Blue Bells of Scotland," with Variations.

Glee	"Strike the Lyre"	*Cooke.*
Song and Chorus	"A Sailor's Song"	
Glee	"Queen of the Valley"	*Calcott.*
Glee	"A Village Wedding"	*Laurent de Rille.*

Bells—"Harmonious Blacksmith," with Anvil and Triplet Variations.

Bells—Selection from "Les Cloches de Corneville" (*Planquette*).

Part Song	"Tar's Song"	*J. L. Hatton.*

Bells—Imitation of Village Chimes.

Glee	"Sigh no more, ladies"	*Stevens.*
Glee	"Sleep, Gentle Lady"	*Bishop.*

Miss Helen Hopekirk gave a Pianoforte Recital in the Picture Gallery, the following being the programme:—

Romance from "Tannhaüser" March from "Tannhaüser"	*Wagner—Liszt.*
Gavotte	*Gluck—Brahms.*
Moments Musicaux	*Schubert.*
Nachtsück, No. 4 Finale aus Symphonische Etuden	*Schumann.*
Polonaise	*Weber.*
Berceuse Ballade	*Chopin.*

The number of visitors attending the *Conversazione* was 2,790.

INDIAN SECTION.

Friday, June 2, 1882; ANDREW CASSELS, member of the Council, in the chair.

The paper read was—

ON THE PRODUCTION OF TEA, CHINCHONA, WILD SILKS, AND RHEA, IN INDIA.

By J. R. ROYLE.

In addressing the Society of Arts on the present occasion, on the production of tea, chinchona, wild silks, and rhea, in India, I shall not attempt to trace the early history and every stage in the development of the trade in each of these substances. That has been done by others, and this Section of the Society has, on several former occasions, listened to most interesting papers, read by men who have in many cases devoted the greater part of a lifetime to their subject, and who have communicated the amplest details on these points. What I intend to do, is simply to trace the great progress which has been made during the last few years in the trade in the first three substances on my list, and to give a slight sketch of some of the attempts which have been made to develop a trade in rhea fibre.

TEA.

The subject of Indian tea, especially, has been so often brought forward, and so ably dealt with by others, that it may appear almost superfluous to make any further remarks about it, yet I think that some few details, showing the advance made in this industry during recent years, may not be without interest. It can, indeed, be pointed to as an industry which has advanced with more rapid strides than any other in which India is concerned; and there is every reason to believe that it has not, as yet, nearly reached its utmost extension, inasmuch as there is practically no limit to the amount of tea which may be grown in India, and no fear of its not finding a market in this and other countries.

Owing to the difficulty of inducing some managers of tea estates to give returns, it is not possible to state, with absolute correctness, the total area under tea in India and the progress made year by year, but the following tabular statement, compiled from the Statistical Tables for British India, exhibits, with as near an approach to accuracy as is possible, the principal details for each of the three years, 1878, 1879, and 1880, and shows that in 1880 there were 2,691 tea plantations in British India, that the total area under tea was 208,622 acres — of which 162,244 acres were under mature plants—and that the approximate total yield of tea during the year was 42,893,381 lbs.

It is very much to be wished that managers could be induced to see the importance of furnishing the information which would enable Government to make returns of this character perfectly accurate; unfortunately—although, probably, all managers are glad to see a

STATEMENT SHOWING THE POSITION OF TEA CULTIVATION IN BRITISH INDIA DURING THE CALENDAR YEARS 1878, 1879, AND 1880, SO FAR AS RETURNS HAVE BEEN RECEIVED.

Provinces and Districts.	Number of Plantations.			Area under Mature Plants.			Total Area under Tea.			Total Outturn of Tea.		
	1878.	1879.	1880.	1878.	1879.	1880.	1878.	1879.	1880.	1878.	1879.	1880.
				Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	lbs.	lbs.	lbs.
1.—ASSAM, including Cachar, Goalpara, Kamrup, Darrang, Nowgong, Sibsagar, Lakimpur, Khasi and Jaintia Hills.	850	924	1,045	109,577	112,685	120,512	147,840	150,610	153,657	28,509,548	31,386,636	34,013,583
2.—BENGAL, including Darjiling, Julpigoree, Dacca, Chittagong Hill Tracts, Hazareebagh, and Lohardugga.	235	257	274	23,268	25,556	27,341	35,708	38,668	38,805	8,619,028	6,223,651	6,572,481
3.—NORTH-WEST PROVINCES, viz., Kumaon, Garhwál and Dehra Dun.	no return	23	87	2,043	2,347	6,848	3,372	3,456	4,110	728,097	685,626	838,742
4.—PUNJAB, viz., Simla & Kangra.	1,174	1,189	1,195	4,258	4,458	4,816	7,851	8,237	7,596	694,588	735,757	802,995
5.—MADRAS, viz., Nilgiris, Madura, and Malabar.	69	79	84	2,543	2,543	2,573	4,191	4,171	4,275	615,406	645,126	649,460
6.—BRITISH BURMA, viz., Akyab and Tounghoo.	2	2	6	150	150	154	170	170	179	17,000	17,000	16,120
Total for British India	2,330	2,474	2,691	141,839	147,739	162,244	199,132	205,312	208,622	39,183,667	39,693,796	42,893,3

return showing how the tea industry is progressing in other parts of India—they are, in many cases, not willing to communicate any particulars about their own estates. Thus, it is mentioned in the last number of the Statistical Tables for British India that, for the year 1880, 288 plantations in Assam, 20 in Darjíling, and 18 in Chittagong, furnished no returns, and that in Kumaon and Garhwal, with one exception, all the planters failed to furnish the information for which they were asked.

It is only 44 years ago, viz., in 1838, that the first consignment of Indian tea, consisting of the trifling amount of 456 lbs., reached the London market. This consignment sold remarkably well, realising fancy prices, and thus gave great encouragement to the spread of tea cultivation in India. Since that time, the amount exported from India has gone on almost constantly increasing, until the exports for the official year 1880-81 are returned as amounting to 46 millions of pounds, having a value of more than £3,000,000 sterling.

In the *Times* telegram from India of May 15th last, the total outturn of the Indian tea crop of 1882 is estimated at 51,619,000 lbs. of which it is considered that 48,000,000 lbs. will probably be exported to the United Kingdom, and 2,000,000 lbs. to Australia and America.

The following table shows the increase in the exports year by year for the last ten years; at the same time, it shows that the value of the exports has not increased in the same ratio as the quantity; but this is due, not to a fall in the relative value of Indian as compared with China produce, but to the low prices which have universally ruled for teas during the last two or three years:—

EXPORTS OF INDIAN TEA FROM INDIA.

Year.	Quantity exported.	Value.
	lbs.	£
1870-71	13,232,232	1,120,517
1871-72	17,187,328	1,454,985
1872-73	17,789,911	1,577,691
1873-74	19,324,235	1,742,926
1874-75	21,137,087	1.937,429
1875-76	24,361,599	2,166,417
1876-77	27,784,124	2.607,425
1877-78	33,459,075	3,044,571
1878-79	34,432,573	3,138,423
1879-80	38,174,521	3,051,020
1880-81	46,413,510	3,054,240

But the amount shown above does not by any means represent the total quantity of tea manufactured in India, for the amount consumed in India itself is by no means inconsiderable, while very large quantities of the tea from Kangra, Kumaon, Garhwal, and other parts of the north-west of India, are sold on the spot to Afghan and other traders, for export to Cabul and the central Asian market. In 1876-77 no less than 1,854,922 lbs. of tea are returned as having been so exported, but this amount fell off considerably during the following year, owing to the war in Afghanistan. In 1878-79 the quantity exported began to rise again, although it did not reach much more than half the amount of 1876-77; but in the last year for which the figures are, as yet, available (1879-80), a further diminution occurred, the amount for that year being only 882,566 lbs.; considering the great importance of utilising every outlet, however small, for Indian produce, it will be worth ascertaining what is the probable cause of this falling off, and whether any remedy can be proposed.

For the following figures, which show the movement of this trade during the last nine years, as well as for many of the other figures I have made use of in this paper, I am indebted to Mr. C. Campbell Prinsep, Statistical Reporter at the India Office:—

EXPORTS OF TEA FROM THE PUNJAB.

YEAR.	To Cabul only.		Total Exports of Tea from the Punjab.	
	Quantity. lbs.	Value. £	Quantity. lbs.	Value. £
1871-72	262,564	43,881	499,052	44,286
1872-73	150,552	34,256	685,930	79,459
1873-74	42,312	5,835	431,238	42,530
1874-75	841,812	146,353	1,589,078	206,496
1875-76	1,063,540	185,244	1,922,080	265,250
1876-77	1,854,922	360,724	2,058,036	381,892
1877-78	997,194	154,873	1,248,286	181,636
1878-79	1,094,782	151,108	1,236,232	162,184
1879-80	882,566	136,358	1,087,730	149,699

As might be expected, the greater part of the increase in the exports of tea from India by sea has come to England, and the secretary to the Indian Tea Districts Association has been good enough to send me the following short statement, from which it will be seen that during the last twelve years the imports of Indian tea into England have increased more than 350 per cent., viz., from a little more than 13 millions of pounds in 1870, to nearly 46 millions of pounds in 1881:—

	Imports.	Deliveries.
1870	13,148,168	13,472,800
1871	15,351,672	13,560,120
1872	16,942,030	16,272,060
1873	18,424,077	18,392,061
1874	17,377,976	17,756,640
1875	25,605,132	23,273,994
1876	29,383,788	26,733,820
1877	31,883,310	28,011,600
1878	36,007,140	36,766,460
1879	38,483,684	35,243,194
1880	45,010,554	43,500,000
1881	45,765,000	48,500,000

These figures differ slightly from those given in the "Annual Statements of the Trade of the United Kingdom," because they are calculated from the average number of lbs. per package received into the warehouses during the year, whereas the official figures represent the actual number of lbs. of tea on which duty was chargeable in each year. I have extracted the figures from the several returns, and here give them side by side with the imports from China for facility of comparison. It will be noted that, while there is so large an increase in the imports of Indian tea, those of China tea have actually decreased from what they were five years ago. This is satisfactory, in so far as it exhibits not only an increased consumption of non-intoxicating beverages, but also an actual appreciation of those good qualities, and that freedom from adulteration, for which Indian tea is celebrated, and which have led to its largely-increased importation:—

IMPORTS OF TEA FROM CHINA AND INDIA, YEAR BY YEAR, FROM 1870 TO 1880.

Year.	Amount Imported from		Total lbs.
	China.	India.	
	lbs.	lbs.	
1870..	125,593,878	12,923,993	141,020,767
1871..	151,636,036	15,150,958	166,786,994
1872..	160,520,882	16,445,170	176,966,052
1873..	137,246,372	18,471,063	155,717,435
1874..	133,452,693	17,608,538	151,061,231
1875..	170,462,921	25,427,767	195,890,688
1876..	155,907,582	27,814,214	183,721,796
1877..	154,996,561	30,940,724	185,937,285
1878..	164,704,642	35,420,059	200,124,701
1879..	141,644,277	38,241,030	179,885,307
1880..	158,195,142	45,138,111	206,971,570

A table published in the *Statist* of October 1st, 1881, shows the average monthly consumption of tea in this country during each year, from 1871 to the present time, and the per-centage to the total supply of Indian and China teas respectively. By this table it appears that whereas, in 1871, only 11 per cent. of Indian tea was consumed, the proportion has risen steadily, until during the first eight months of 1881, it amounted to 30 per cent. of the total quantity consumed, and that the difficulty which was for many years felt of overcoming prejudices, and of inducing people to depart from their long-established custom, and to order Indian instead of, or to mix with, China teas, has at last, to a great extent, been overcome.

The rage for cheap teas during the last few years, which has had the extraordinary effect, among others, of inducing people to believe that they are getting a cheap and good tea, because they can receive, as a bonus, a book or a flower vase if only they will purchase their tea of certain companies, has not been without its bad effects on Indian tea growers, whose profits have been reduced to almost *nil* by the low prices prevailing; but prices have lately been somewhat improving, and as new openings for the trade are discovered, the probability of fair rates being maintained will be largely increased.

During the last few years, attention has been drawn to the desirability of not only increasing the exports of tea from India to this country, but also of finding new fields; and the efforts of the Calcutta Tea Syndicate (which was founded to promote the interests of Indian tea growers and merchants), in this respect, have been crowned with a fair amount of success. Especial prominence was given to Indian tea at the Melbourne Exhibition, in 1880, at which samples from all the Indian tea districts were shown by the Syndicate, with the result that a large increase of trade between India and that port has taken place; this will be at once seen when it is mentioned that the exports of Indian tea to Australia, which were in 1879-80 only 85,994 lbs., rose in the following year to 807,608 lbs, At present, with the exception of small consignments to Adelaide, Dunedin, and Brisbane, not much progress has been made in other parts of Australia than Melbourne, and here, seeing that the Australians import annually from China about 20 millions of pounds of tea, there is a large field for enterprise.

Encouraged by the success of their efforts in Australia, the Calcutta Tea Syndicate determined to try and open a trade with the United States of America and Canada; with this view they sent to America an expert thoroughly conversant with the Indian tea market, and furnished with samples of all such descriptions of tea as were thought likely to suit the American market; the Government of India made the Syndicate a small grant in aid of their object, with the view of helping to set the trade in motion, and according to the last advices received by the Syndicate, their agent was already obtaining large orders from New York and Chicago.

Among the obstacles to the development of the Indian tea trade, must be mentioned the Customs duty which is imposed in this country on all tea imported, whether from India or elsewhere. Sir J. and General R. Strachey have pointed out in their "Finances and Public Works of India" that this duty, which is at no less a rate than 50 per cent. on the average value, imposes a burden of more than one million sterling on Indian tea growers. So soon as her Majesty's Government can see their way to its abolition, there can be no doubt that the tea-growers, among others, will be benefited by the increased sale, in consequence of reduced prices; but seeing that the duty in question realised no less than £4,280,000 in 1881, its total abolition can scarcely be looked for immediately.

Another obstacle, which owes its existence to the duties, but which could apparently be removed without great difficulty, is the present mode of weighing teas in the bonded warehouses in London for the purpose of levying the duties. For this purpose the Customs officials ignore the invoice weights, and actually weigh each package; they then empty a certain number of cases (about ten per cent.) in each break, and weigh the empty cases; if these test packages turn out to be very nearly of the same weight, they determine the weight to be assigned to each package of that break, but if the variation in weight exceeds a certain limit, then each case is emptied and weighed—much to the detriment of the contents. In fact, the Customs authorities take an average formed by dividing the total nett weight by the number of packages weighed, and they allow in favour of the buyer any fractions which may occur in the division.

The reason why this system is peculiarly hard on Indian tea-growers is that Indian teas are packed on the plantations, frequently in small breaks—and in boxes of any wood which can be obtained on the spot, and which are made of only approximately even weight; it thus frequently happens, that every box has to be opened and emptied. China teas are snbjected to the same system, but as they are generally packed at the shipping ports in large breaks, and where cases of uniform size and weight can more readily be made, it is rare that more than ten per cent. have to be opened as test packages.

As a remedy for this state of things, it has been proposed that the contents of the cases, and not the empty packages, should be the governing factor in determining the weight of tea. It would be easy to ensure the packing of a uniform weight of tea in each chest, though there is reason to believe that, at present, tea-growers are not sufficiently careful on this point.

An idea may be formed of the large sum of money which may be put in circulation by the development of a trade in even so comparatively unimportant an article as tea, when it is mentioned that, up to the 31st March, 1881, there had been registered in India no less than 160 joint-stock companies, having for their object, either wholly or in part, the cultivation and manufacture of tea. Of these, thirty-four have been dissolved, and either become defunct or been registered again under new titles; one never commenced business; nineteen are now in course of winding up; and the remaining 106 with a capital of Rs. 271,69,716 (equivalent, at 2s. per rupee, to nearly 2¾ millions sterling), are still working. To this sum would have to be added the capital employed by owners of private estates, but there are, unfortunately, no figures available on which to found an estimate of the amount so employed.

CHINCHONA.

Considering the comparatively short time which has elapsed since its introduction into India, the progress which chinchona cultivation has made is scarcely less remarkable than is that of tea. Although its introduction had been urged for years by different scientific men, it was not until 1859 that Mr. Clements Markham, to whose energy and perseverance India is really indebted for this valuable tree, was deputed to visit South America, and thence to bring back young plants and seeds of those varieties of chinchona which were thought most likely to succeed in India. Early in the following year, Mr. Markham, accompanied by an experienced gardener, named John Weir, reached South America, where he determined to explore the Calisaya region;

at the same time, he arranged that Messrs. Spruce and Cross should explore the red bark forests, and that Mr. Pritchett should examine the grey bark forests near Huanaco. All the exploring parties met with great difficulties on their routes, more especially through the extreme jealousy of the natives, who were strongly opposed to any plants or seeds of the valuable species leaving the country; still, a number of plants were procured, and were conveyed to India, after several unavoidable delays; these delays, unfortunately, proved fatal to the majority of the plants, and only those of *C. succirubra*, which were procured by Messrs. Spruce and Cross, safely reached India; of the other varieties, seeds were ultimately obtained, and the propagation had to be carried on from these.

Mr. Markham selected sites suitable for chinchona plantations in the Nilgiri Hills in 1860, and, subsequently, at other places in the Madras Presidency, and the young plants and seeds were there placed under the charge of Mr. McIvor, who was so successful in their propagation that, in April, 1862, he was able to report that there were no less than 31,495 plants of various species under his charge; and as the area of the plantations was steadily increased year by year up to 1870, the number of plants increased in like proportion, so that at the end of the year 1873-74, Mr. McIvor calculated that the total number of plants of all species in the Nilgiri plantations was 1,190,458. About this period, the Government decided to discontinue any further extension of the plantations, excepting for the propagation of new and valuable species, and after Mr. McIvor's death in 1876, they directed Captain Campbell Walker (Deputy Conservator of Forests) to report thoroughly on the past and present condition of the Nilgiri chinchona plantations; at the same time, requesting him to offer any suggestions as to their future management which might occur to him.

Captain Campbell Walker, as a preliminary step, set about what had never before been undertaken—a systematic division of the plantations into blocks of convenient size, and an enumeration of the exact number of trees contained in each block. By these means, he ascertained that the total number of trees must either have been over-estimated, or that a considerable number must have died, as the actual number existing at the date of his valuable and exhaustive report, in 1878, was only 569,031, which he classified as follows, viz.:—

Red Bark	260,837
Crown Bark	305,432
Yellow Bark	552
Grey Bark	1,874
Other Species	336
Total	569,031

At the same time he reported the total area under cultivation to be 842·92 acres. The number of trees was still further reduced during the course of the following years by the sale of plants to private growers, so that at the end of the year 1879-80, the total was only 540,772; but it was then reported that the raising of plants from seed was beginning to be so thoroughly understood, that Government was not likely to be called on in future to supply any large number of plants.

Captain Campbell Walker estimated the probable eventual yield of the Nilgiri plantations, so soon as all the trees were of an age to yield bark, at over 390,000 lbs. of dry bark, but this estimate was considered by the Chinchona Committee to be too sanguine, and they thought that 200,000 lbs. was a safer estimate; the actual yield during the last four years for which reports have been received was:—

	lbs.
In 1877-78	138,838
„ 1878-79	114,320
„ 1879-80	179,299
„ 1880-81	243,896

As regards the financial results of the Government plantations in the Nilgiris, Captain Campbell Walker's report showed the total cost of the plantations, including compound interest up to the end of the year 1875-76, and also the total receipts from sale of bark, plants and seed, which still left a considerable balance of charges to be repaid, but this balance was reduced, year by year, until the reports for the year 1879-80 gave the gratifying intelligence that the outlay on these plantations had been entirely repaid. Thus it was shown that the

	Rupees.
Total outlay had been	12,00,372
Interest	5,49,462
Total expenditure	17,49,834
Total receipts	14,81,984
Leaving a debit at the close of the year 1879-80 of	2,67,850

But the receipts from the sale of that portion of the year's crop of bark which had already been disposed of, exceeded this amount, and thus entirely extinguished the debt, leaving

Government in possession of plantations of an estimated value of £500,000.

The primary object of Government in establishing these plantations, was to provide the people of the country with a cheap febrifuge, and with this idea, it was for some years considered advisable to extract the alkaloids from the bark on the spot—a Government quinologist being engaged for this purpose—but after a time it was discovered that the prime cost of the bark was too great, and the process of manufacture employed too expensive, and not sufficiently exhaustive to enable the Government to produce, economically, a cheap febrifuge. The Chinchona Committee's Report in 1878, showed, that by Mr. Broughton's process, which was employed in the Nilgiris, not more than 64 per cent. of the alkaloids contained in the bark were recovered, whereas, in commercial manufacture, from 85 to 90 per cent. is considered to be recoverable. The committee came to the conclusion that, without a full factory establishment, it would be impossible to ensure obtaining a full per-centage of alkaloids, and that it was impossible for any Government establishment to compete successfnlly with manufacturers who had devoted a lifetime to the study of the economical extraction of chinchona alkaloids; it was, therefore, determined to abolish the Government factory in the Nilgiris, and to adopt the plan of sending the bark home to be sold in England, where also Government could purchase in the open market such supplies of the different chinchona alkaloids as they might require for use in the Madras and Bombay Presidencies.

This plan was followed for some years, but in 1880 it was determined to try the experiment of manufacturing the alkaloids from Nilgiri bark in this country on Government account, and sending the products to India for use in the hospitals and dispensaries. By this means, quinine and other alkaloids are obtained at a cheaper rate than under the previous arrangement, thus fulfilling more completely the original object of Government plantations, viz.: the supply of a cheap febrifuge for the people of India.

Much has been said about the advisability of Government at once disposing of their chinchona plantations in the Nilgiris, and of their ceasing to interfere any longer with private enterprise, but the truth is, that the ready sale met with by the Government bark in this country, has done more than anything else to encourage private enterprise, by showing to intending planters that they would have no difficulty in disposing of the produce of their plantations at remunerative prices. Moreover, there are many important questions connected with the cultivation of the plants, the harvesting of the bark, and the trial of new species, which have still to be settled by experiment, and these experiments private firms could not afford to undertake, while Government, with plantations which have already repaid their cost, can afford to do so.

In the Bengal Presidency, chinchona cultivation was commenced in 1861, when a few seeds reached the Botanical Gardens, Calcutta, and were there reared, while, during the same year, Dr. Anderson, superintendent of the gardens, visited Java and the Nilgiris, and procured a supply of young plants, of different species; he soon afterwards recommended the establishment of a plantation in the Darjiling Hills, in British Sikkim, and here, after several experiments and failures, he at length succeeded in finding some suitable sites, and the work of propagation was carried on with such vigour, that the number of plants of all varieties, in permanent plantation, were returned as being in—

1878-79	4,028,055
1879-80	4,632,737
1880-81	4,671,720

Of this last number, more than four million of plants were of the red bark, or *succirubra* variety, while 406,695 were of the yellow bark, or *calisaya* species.

The total area under chinchona in this part of India is returned as 2,332 acres, and the yield of dry bark was, in—

1878-79	261,659 lbs.
1879-80	361,590 lbs.
1880-81	377,525 lbs.

With the exception of 14,240 lbs. of the yellow or *calisaya* bark, which were sent to England for sale in 1880-81, nearly the whole of this bark was transferred to the Darjiling Government factory, where for some years past the manufacture of an amorphous mixed alkaloid, called "quinetum," has been carried on. This alkaloid has proved very efficacious as a febrifuge, and much cheaper than quinine purchased in this country. The process of manufacture is, however, not a satisfactory one, as only about half the alkaloids contained in the bark are obtained, the remainder being lost. The alkaloids obtained consist chiefly of cinchonine and cinchonidine, the more valuable alkaloid, quinine, contained in the bark, being almost entirely lost.

This being the case, it can hardly be contended that the manufacture has hitherto been economical, although the use of the febrifuge has resulted in a considerable saving to those who have employed it in the place of the more expensive sulphate of quinine. Mr. F. C. Danvers, who has taken the greatest interest in this question, is of opinion that if the manufacture, locally, is continued, an endeavour should be made to place it on a better and more scientific footing, so as to ensure the recovery of the whole of the alkaloids.

The following statement shows how rapidly and continuously the manufacture of this febrifuge has increased. Thus, there were manufactured in—

	lbs.
1874-75	48
1875-76	1,940
1876-77	3,750
1877-78	5,166
1878-79	7,007
1879-80	9,435
1880-81	9,296
Total amount manufactured	36,638

As first manufactured, it was found that, although the febrifuge was, in many cases, as effective as the much more costly quinine, yet there were a considerable number of patients who could not take it owing to the nausea which it caused in them. In 1877, the Government of India appointed a scientific committee to determine how far the component parts of the febrifuge mixture might be modified; and they, considering that the gastric disturbance was caused by the presence of certain amorphous constituents, recommended that these should in future be excluded. The new mixture recommended by the committee was, consequently, tried, and being found not to create the nausea previously complained of, the new formula has since been adhered to.

Attempts have also been made to manufacture sulphate of quinine at the Darjiling factory, and it is reported that the results are satisfactory, although no details have as yet been received concerning the process employed, or the cost.

During the year 1880-81, the total receipts by the sale of bark, febrifuge, and plants from the Sikkim plantations were Rs. 179,657 2a. 11p., and this sum, after payment of all expenses connected with the plantations and the factory, left a profit of more than Rs. 80,000, or sufficient to pay interest at the rate of 8 per cent. per annum on a capital of rather less than ten lakhs of rupees, which sum represents the total expenditure on the plantations from their first establishment, including compound interest at the rate of 4½ per cent. per annum. In addition to this, the value of the stock of febrifuge in hand must be taken into consideration, and this, at its cost price, represented a further sum of Rs. 94,924.

Small Government plantations have been started both in British Burma and Mysore; but these, although thriving, have not begun to yield any considerable amount of bark. The following table shows, approximately, the number of acres under chinchona cultivation in British India, together with the total number of plants in permanent plantation on the 31st March, 1881, as well as the out-turn of bark for the year 1880-81:—

Table showing Acreage and Number of Plants in the Government and Private Plantations in India on the 31st March, 1881, as also the Outturn of Bark for the Year 1880-81, as accurately as can be ascertained from existing Returns:—

	Plantations.	Acres under cultivation.	Number of plants in permanent plantation.	Out-turn of Bark for the year 1880-81
				lbs.
Government	Sikkim	2,332	4,671,720	377,525
	Burma	*	44,028	290
	Mysore	41	35,735	*
	Nilgiris	847	677,355	243,245
	Total Governmnt. plantations	3,220	5,428,838	621,060
Private	Bengal	1,129	1,366,090	300,000
	Mysore	10¼	7,125	*
	Coorg	*	380,835	*
	Total private plantations	1,139¼	1,754,050	300,000
	Total Government	3,220	5,428,838	621,060
	,, Private	1,139¼	1,754,050	300,000
	Grand total	4,359¼	7,182,888	921,060

WILD SILKS.

It is much to be regretted that the exports of Indian raw silk have been for some years past steadily diminishing. In the year 1870-71, they amounted to 2,131,399 lbs., valued at £1,258,527, while, in 1880-81, they were only 1,302,576 lbs., valued at £548,202.

It is maintained by some, that this diminution is not to be interpreted as meaning a corresponding diminution of the amount of silk produced in India, but that the falling off

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* No information available.

in the exports is caused by the fact that a much larger proportion of native produced silk than formerly is consumed by the Indian manufacturers for use in the country itself. It is not possible, at present, to either confirm or disprove this view; but the fact that India's inports of silk have, during the last few years, increased almost as much as her exports have diminished, is certainly not in its favour.

Mr. O'Conor, in his review of the trade of British India for the year 1880-81, draws special attention to this point, and remarks that, "at the present rate of decline, this trade will, in a few years, be a thing of the past."

The following statement gives, side by side, the exports and imports of Indian raw silk, year by year, for each of the past ten years :—

Exports of Raw Silk.			Imports of Raw Silk.	
Years.	Quantity.	Value.	Quantity.	Value.
	lbs.	£	lbs.	£
1871-72 ...	1,893,322	1,081,097	1,799,591	651,595
1872-73 ...	2,231,578	1,256,356	1,930,910	659,480
1873-74 ...	2,223,917	1,143,744	2,282,758	786,914
1874-75 ...	1,656,015	766,462	2,469,255	872,927
1875-76 ...	1,310,569	415,961	2,466,244	694,889
1876-77 ...	1,417,893	776,904	1,461,069	451,895
1877-78 ...	1,512,819	703,549	2,102,980	678,140
1878-79 ...	1,329,599	570,229	1,813,993	567,236
1879-80 ...	1,401,506	516,157	2,005,020	683,235
1880-81 ...	1,302,576	548,202	2,511,802	1,067,018

Without attempting, at present, to seek for the cause of the great falling off in production which is apparently shown by these figures, it cannot but be right to encourage the development of a trade in any substance which will supplement the supply of mulberry silk now received from India, and such a substance we have in the silks of various worms which exist abundantly in the jungles of all parts of India, where they feed on the leaves of various shrubs and trees, and need no attention from the hand of man. These silks, which have been named wild silks, in contradistinction to the so-called mulberry silks, cannot, indeed, be expected to supplant the latter, for they are not suited to all the branches of manufacture for which mulberry silks are adapted, but they are certain to largely augment the total amount of silk exported from India, and they have, during the last few years, been turned to many industrial uses for which it was not formerly thought they could be serviceable.

The term "wild silks" was originally applied indiscriminately to the produce of all worms which do not feed on the leaves of trees or shrubs specially cultivated for them; it is now applied to the produce of all worms except those which feed on the leaves of the mulberry, notwithstanding the fact that the so-called "wild" silkworms are in some cases bred in captivity, and reared on leaves of shrubs which may have been specially planted for their benefit.

In his excellent "Handbook of the Collection Illustrative of the Wild Silks of India in the India Museum," Mr. Wardle gives a complete list, compiled by Mr. F. Moore, of the silk-producing *lepidoptera* of India, and this list includes no less than 57 varieties; but besides the mulberry-feeding worms, there are not more than about a dozen species which are utilised at present, and of these, only three—the Tasar, Eria, and Moonga—to any important extent, while the produce of only one—the Tasar—is as yet exported from India in any quantity. Mr. Wardle gives a list of 17 trees and shrubs which are common to various parts of India, and on the leaves of which the Tasar worms feed, and the fact that these numerous food trees are spread over so wide an area, causes the Tasar worms to be known nearly all over India.

The produce of the Tasar worms has been for many years known in London, principally in the form of piece goods of a creamy or light brown colour, which were used, to a limited extent, for ladies' dresses, but the great advance in the use of this silk has been since the Paris Exhibition of 1878, where attention was attracted to the fine collection of wild silks exhibited by the Indian Government and arranged by Mr. Wardle, whose labours in the endeavour to introduce Indian wild silks more extensively into commercial use, are well-known to this Society.

Apart from the deficient supply, two principal reasons have, for years, prevented the use of any considerable amount of Tasar silk in European manufactures. The first of these was the extreme difficulty with which the silk would take any dye, except in dark shades, and the second was the thickness of the thrown Tasar silk, as reeled by the natives. As regards the dye-resisting quality, this was ascertained to be caused by the naturally dark colour of the silk, and this dark colour was found not to yield to any of the ordinary bleaching agents. But, after many experiments, M. Tessié du Motay discovered that the dark colouring matter would yield to permanganate of potash, and this proving too powerful an agent, he eventually substituted binoxide of barium in a solid form. This agent is perfectly successful as regards bleaching the silk, and enabling it to receive any dyes, but its application is, unfortunately, costly, and Mr. Wardle hopes that, before long, some further discovery will enable dyers to apply the bleaching agent in a liquid and cheaper form.

While on the subject of bleaching, it may be mentioned that Major Coussmaker has succeeded in obtaining in India, Tasar silk which is free from all brown shade, by causing the caterpillars to void all their cement, which contains the colouring matter, before they commence to spin their cocoons. He has not thoroughly explained his method, but if he can succeed in applying it on a large scale, it is likely to have valuable results.

Mr. Wardle has succeeded in imparting the darker shades of the aniline dyes, and some of the more permanent vegetable dyes, readily to Tasar silk, and he has devoted his attention more especially to the utilisation of native Indian dyes, with many of which he has been remarkably successful. It will thus be seen that the dyeing difficulty has already been to a great extent, and is likely to be in time completely overcome, and there are good reasons to hope that before long the reeling difficulty also will disappear, for Mr. Wardle discovered some years ago that, by using the Italian reeling system, he could obtain thrown Tasar silk of the size of 51 deniers (or three drams per 1,000 yards), whereas the ordinary size of the Tasar silk of commerce had up to that time been from 152 to 255 deniers (*i.e.*, 9 to 15 drams weight per skein of 1,000 yards). This proved that the native system of reeling was alone at fault, and that so soon as the natives could be induced to adopt an improved style of reeling, the value of the Tasar silk would be greatly increased, as it would be more suited to commercial use in Europe. But most of the improved reeling machines are more or less costly, and are on that account not likely to be ever used by the poorer classes of natives who can, however, readily collect cocoons and reel them in their own primitive way; it is, therefore, probable that the most effectual way of improving the quality of the reeled silk will be by the establishment of several central filatures with outlying agencies, to which the cocoons can be brought by the natives, and where they will be at once paid, according to a fixed scale, for all they bring.

The system of inducing natives to collect cocoons has been already adopted in Poona, where the Forest Department has issued instructions to its officers to pay a fixed price for all wild cocoons that are brought to them. In this way 17,000 cocoons were collected in 1880, and 58,000 in 1881; 200 lbs. of clean cocoons were obtained from the collections of these two years, and these have been forwarded to Mr. Wardle to report on. Major Coussmaker is of opinion that the number collected, would be largely increased, were English planters to supervise the details of the collection, taking care that instead of instructions being, as at present, handed down from one to the other, until at last the village boy who collects the cocoons while watching his cattle is reached, the instructions should be given, and the payment made direct to the actual collectors.

Mr. Wardle, not long ago, showed to this Society some beautiful examples of the various uses to which Tasar silk can now be put, and he is still engaged in further developing its uses. Among the more recent developments, may be named the use of Tasar silk floss for embroidery, for carpets, and for the manufacture of plush, for all of which purposes it is eminently adapted, both by its softness, great strength, and brilliant lustre. Printing in colours, or in gold, on Tasar silk piece goods, has also been very successfully carried out, and some of the effects produced are very pleasing. Sir George Birdwood has kindly allowed me to show, this evening, a rug which Mr. Wardle has just made for him, and which is an excellent illustration of one of the most recent applications of this material. Mr. Wardle has also lent two or three specimens of printing in colours on Tasar silk.

Hitherto, although much information has been gathered concerning the wild silks of India, and although many successful experiments for their application in the arts have been made, it appears as if China, rather than India, had benefited, but it is to be hoped that this state of things will not long continue, for there are fortunately many zealous workers, both in India and in Europe, whose object it is to extend the Indian silk industry.

Among species of wild silkworms which have recently been successfully introduced into new parts of India, allusion must be made to the Assam species of castor-oil worm, or "Eria," which Messrs. Lister and Co., in their report of operations during 1881, say they have introduced into the Dehra Dún, where it was thriving at the date of their report, although they had some fears as to its standing the cold of the winter in that part of India.

A few weeks ago Mr. W. Martin Wood called attention in the *Journal* of this Society to the desirability of encouraging the introduction of a fertile hybrid silk-moth which was produced at Bombay seven or eight years ago, and which he proposed to name provisionally Yamma-paphia Mowisia; this moth is the result of a cross between the Yamma-mai of Japan, and the Tasar moth of the Deccan, and as the worm feeds on the bhair tree, *Zizyphus jujuba*, and on nearly every kind of *ficus*, it might be readily spread over the greater part of India without needing any special plantations for its food.

It is difficult to ascertain the exact amount of Tasar silk which is exported from India, as in the shipping bills it is not specified separately from other raw silks, but the Collector of Customs, at Calcutta, has estimated that the amount was, in 1878, 7,466 lbs.; in 1879, 18,664 lbs.; and in 1880, 79,146 lbs. These figures show that, at any rate, some good has resulted from the labours of those who have been endeavouring to encourage the use of this article.

RHEA.

The fibre known under the varion commercial names of rhea, ramie, and China grass, is one that has, of late years, attracted considerable attention, owing to the rewards which were offered by the Government of India for the best machine or process adapted for stripping the fibrous envelope of this nettle from the stems, and for freeing it from the gummy matter with which it is highly charged.

Efforts to encourage the production of this plant in India were commenced early in the present century, when Dr. Roxburgh obtained a few plants of a species of *Urtica*, which he named *Urtica tenacissima* (on account of the great strength of its fibre), from Sumatra, and from these a great number of plants were reared at the Hon. Company's Botanical Garden at Seebpore. The first fibre from these plants was sent to England in 1810, and was very favourably reported on as a cordage material, on account of its exceeding strength; owing, however, to the lack of suitable machinery for its preparation, no further efforts worth mentioning were made for some years. In 1840, Colonel Jenkins discovered the plant growing wild in Assam, and it had, even before this date, been found to be identical with one grown in the Rungpore and Dinagepore districts, under the name of khnokhoora. Not long afterwards, Dr. Falconer and Sir Wm. Hooker were able to identify this *urtica*, khonkhoora, or rhea, as the same plant as that from which the Chinese grass-cloth was made, and in 1854, the Court of Directors, in forwarding to India a memorandum on the fibre, by Dr Forbes Royle, directed the purchase of ten tons of rhea fibre annually, for three years, in order to encourage its cultivation, After this, the fibre being well known in England, it was considered that its further development might be left to private enterprise; events, however, proved that the obstacles to the development of its commercial use had not yet been removed.

In 1869, the Government of India took the matter up, and after obtaining all the information that could be furnished by the Agri-Horticultural Societies in India, and by gentlemen who had been for years engaged in experiments with rhea, came to the conclusion that all the conditions necessary for its cultivation in India on a large scale existed, and that all that was wanted was some machine or process suitable for separating the fibre from the stems and bark of the plant in its green state. They, therefore, issued a notification offering prizes of £5,000 and £2,000 for the two best machines, the merits of which were to be tested in India, the principle condition being that fibre worth £50 per ton in the English market, should be produced at a cost not exceeding £15 per ton in India. The trials were eventually fixed to take place in April, 1872, at Sahâranpur, and a plantation of rhea was there established in order that the necessary raw material might be obtainable on the spot. No less than 32 competitors entered for the trials, but at last only one—Mr. Greig—put in an appearance. Mr. Greig's machine was duly tried, but the cost of preparing clean fibre by it was found to exceed the stipulated £15 per ton, while the samples of fibre prepared were valued in London at only £28, and declared fit only for cordage purposes. This being the case, it was impossible to award the full amount of the prize to the inventor, but he received £1,500 in recognition of the merits of the machine.

During the next few years, Dr. Forbes Watson—whose name will always be associated with the attempts to bring rhea into use in manufactures — exerted himself with great energy and success in this country in endeavouring to make the fibre more generally known, and he was fortunate in obtaining a supply of China grass seed, as well as of green stems, which were advertised under the authority of the Secretary of State for India, and distributed to all applicants who were willing either to try to grow the plant or to experiment on the stems. In 1875, Dr. Forbes Watson pointed out the extreme difficulty of inducing any large number of competitors to incur the expense of taking their machines to India in order to compete for a prize, and suggested that trials should be held in this country instead. It was, therefore, at last determined that experiments should be made in London, both with green stems grown in Europe, and with dried stems procured from India, and it was hoped that everything would have been ready for the trials by November, 1875. Several inventors entered their machines for competition, although no prize was offered; but, unfortunately, owing to unforeseen difficulties, it was found impossible to hold the proposed trials.

This being the case, the Government of India, in 1877, issued a new notification, in which, after referring to the prize offered in 1869, and to the fact that the only machine brought forward to compete for it was not considered entitled to the full reward, and had not since been adapted by the inventor to practical use, they proceeded to state that the demand for rhea still continued, and that the conditions which induced the Government at that time to offer a prize, remained substantially unchanged. They, therefore, again offered a prize of Rs. 50,000 to the inventor of the best, and Rs. 10,000 to the inventor of the second best machine or process for preparing rhea fibre; the machine or process to be capable of producing, by animal, water, or steam-power, fibre of an average value of not less than £45 per ton in the English market, at a total cost of not more than £15 per ton, laid down at any port of shipment in India, or £30 per ton in England, after payment of all charges usual in trade. The competition for these prizes was fixed to take place at Sahâranpur, in August and September, 1879, and it eventually took place in September and October of that year. As many as 24 applications for permission to compete were received, but only 10 competitors finally arrived at Sahâranpur, and 3 of these withdrew before the commencement of the trials, leaving 7, viz.:—M. Van der Ploeg, M. Nagoua, Dr. Collyer, Messrs. Labérie and Berthet, Mr. Cameron, Mr. Amery, and Mr. Blechynden, to compete for the prizes. The fibres prepared by each of the competitors were carefully packed and sent to London for valuing, with the result that none of them were valued at anything like the stipulated £45 per ton; the highest value, indeed, affixed to any of the samples by Messrs. Noble and Co., was £26 per ton. Messrs. Mark Dawson and Son also examined the specimens of fibre, and reported very unfavourably on them, saying that even the best were a long way from being equal to the fibre imported from China. But they offered to pay £25 per ton for one or two tons like some of the best samples, in order that they might put it through all their various processes of manufacture, and see what it was worth. At this time China grass was selling at £50 per ton in the English market.

On receipt of these unfavorable reports, the Government of India felt themselves unable to award the prizes which had been offered; but they made awards of Rs. 5,000 each to Messrs. Van der Ploeg and Nagoua, and of Rs. 1,000 to Mr. Cameron, the competitors whose samples were considered the best by the English experts. Judging from the reports on the samples, the Government of India came to the conclusion that it did not seem probable that Indian rhea fibre would be able, at present, to compete successfully with the Chinese product, and that in most parts of India the cultivation of the plant could not be undertaken with profit. They considered that the soil and conditions of climate might be found suitable in parts of Burma, Upper Assam, and in some districts of eastern and northern Bengal; and that if it could be grown in such places, with no more care than is required for a superior crop in an ordinary well-farmed field, it might possibly succeed commercially. They were, however, of opinion that it would be inadvisable to renew the offer of a prize for a suitable machine until such time as private enterprise should have shown that the cultivation of the rhea plant could be undertaken with profit in India, and that there was real need for an improved method of preparing the fibre. Intending growers of the plant can, however, still be provided with roots from the Botanical Gardens at Howrah, for the purpose of starting their plantations.

Here, then, for the present, at least, the matter of the utilisation of Indian-grown rhea rests, so far as Government action is concerned, but private individuals are still diligently working, and will, it is to be hoped, continue to work until the problem of putting an Indian-grown rhea fibre into the market at a price and of a quality which will compete with China grass is solved. Other countries appear to be succeeding in pushing the fibres in which they are interested; for instance, the Dutch have lately been sending over consignments of prepared ramie fibre from Java to the Continent, and some bales have lately reached the English market, where they are stated—although not very well cleaned—to compare not unfavourably with China grass. I have not, however, been able to ascertain by what process this Java fibre is prepared.

In Réunion, a French naval surgeon (M. Renaud) has found a process for easily and rapidly preparing the fibre, by means of an alkaline bath, the strength of which is to be tested by Gay Lussac's densimeter, in order to avoid its being so strong as to weaken the fibre; and in Paris, Messrs. Labérie & Berthet have patented a machine which they have worked for some time, and which is said to prepare about 800 kilogrammes of fibre from green stems per day of ten hours. In America, Messrs. Dennis & Angell have patented a machine which is said to be capable of thoroughly and rapidly preparing the fibre from ramie stems, although it was originally designed for jute; according to the most recent advices, this machine has not yet been perfected, and the inventors purpose carrying out some experiments during the coming summer, with a view to its improvement.

Incidentally, it may he mentioned that, in the course of his experiments, M. Renaud claims to have discovered that the planting of rhea among vines protects the latter from the attacks of the *phylloxera*, and even cures those which are already attacked by that dreaded pest; if events should bear out the correctness of this claim, a great boon will have been conferred on vine growers.

In England, numerous experimentalists—some tempted solely by the hope of gaining the Indian prizes, and others, induced by an honest wish to make a valuable fibre more suitable for use by manufactures, and to add another to the list of useful substances with which India supplies Europe—have, for years, been expending money, and time, and energy, in the endeavour to perfect some machine or process for preparing this fibre for market; but it cannot be said that, as yet, anyone has been entirely successful, though many processes have appeared to act remarkably well with small experimental lots of stems.

Time would not suffice, on the present occasion, to give anything like a complete list of all the experimentalists, but, generally speaking, it would appear that those who have adopted the simplest machinery, or processes, have produced the most satisfactory results. Among others who have devoted a great deal of time to the solution of the problem, I may mention that Mr. Sebastian Anderson has succeeded in producing some very excellent samples, in which the separate filaments of the fibre are all as parallel to one another as they were in the original stems. He has not communicated the details of his process to me; but he tells me that he can, with perfect ease, separate the bark and gum from the fibre of either green or dry stems; after stripping the bark and fibre from the stems by hand, he soaks the strip thus removed in a bath, which, while in no way weakening the fibre, thoroughly removes every particle of bark and gum. He has informed me that he is endeavouring to make arrangements for the carrying out of his process in India, and for the transmission of the prepared fibre to London for sale. It is to be hoped that Mr. Anderson's efforts may be crowned with success, but it is worth considering whether, seeing what a continued demand there is for the fibre which comes from China, and which is all hand-prepared, the first endeavour should not be to imitate as closely as possible the Chinese hand-process—notwithstanding its slowness—and to try to forward from India supplies of hand-prepared fibre of as good a quality as the Chinese. There does not seem to be any insurmountable obstacle in this direction, neither does there seem any reason why the fibre could not be grown and prepared as cheaply in India as in China. Above all things, it is to be hoped that experimentalists will not be discouraged by the results of the trials held at Sahâranpur, in 1879, and that they will not assume that, because the samples of fibre sent to England as the result of those trials were all inferior, both as regards quality and as regards their mode of preparation, therefore India is incapable of growing fibre of good quality, if only she is shown how to prepare it for market.

The proprietors of the Jugdespore estate, in the Shahabad district of the Patna division of Bengal—the estate or zemindary referred to in Mr. Mylne's interesting paper, which was read before this Society last month — thinking it probable that the Indian rhea problem is more likely of solution as a domestic industry than by means of centralised machinery, have been making experiments in that direction, in the cultivation of the plant and hand preparation of the fibre; the results of the former are satisfactory, and the latter has to be introduced into the homes of the people as a new industry. It has been ascertained by experiment that if the green stems are stripped by hand of their envelope of bark and fibre as soon as they are cut, and if the strips are allowed to simmer for a short time in a weak solution of potash, the bark and gum can, with the greatest ease, be scraped or rubbed off from the fibre. Mr. Mylne and his partners propose that this part of the work shall be done mainly by women and children, who will thus be enabled to earn a little money in their own homes; if this part of the scheme succeeds, a great point will have been gained, seeing that the difficulty of finding domestic employment suited to the poorer native women of high caste, who are not permitted to work in the fields, is well known.

The proportion of potash which has been found, after several experiments, to be the best, is about 2½ lbs. to every 100 lbs. of green strips of bark; and the length of time for simmering varies from two to three hours. Some samples of rhea fibre, prepared by this process by natives in India, have been sent over to England, and valued by brokers at £40 a ton, at a time when China grass was at £48; this is a proof of the success of the hand process, and it also appears that the potash bath, when of the proper strength, does not weaken the fibre; for some dry bark has been left to soak in the mixture for from 10 to 15 days, after which time the fibre was found to have lost none of its original strength. It is probable that, before long, some inexpensive mechanical adaption may be found, which will supplement or assist the hand process; and with this view, Mr. Mylne is experimenting with some simple machinery, which he believes will enable the women to separate the fibre from the bark much more rapidly.

If these efforts are successful, they will have the effect not only of creating a new domestic industry in many parts of India, but also of bringing into the English market a fibre which will be more thoroughly cleaned, and at a lower price, than heretofore; when this has been done, it will be suitable for a far wider range of manufactured goods than at present. Owing to its scarcity, and consequent high price, rhea of good quality can now only be used to replace, or mix with, silk or wool; but if only the price would allow, it would be at once found suitable also for use in that far larger class of goods in which flax is now used. It may be safely asserted that cheapness of production and cleanness of fibre are the only two points which need attention in order to create an almost endless demand in this country for Indian rhea fibre; for although there are still certain mechanical difficulties in the manipulation of the fibre in the processes of manufacture, these are not insuperable.

Within the last days I have had an opportunity of seeing at work in London a machine patented by M. Roguet, in which dry rhea stems have been tried; some of the samples produced are shown here this evening, and it will be observed that they are not very free from bark; but it is to be hoped that further experiments may show an improvement in this respect.

It is to be regretted that statistics are not available to show the actual amount of China grass imported into this country during the last few years. Messrs. Manning and Collyer state that, in 1872, about 139 tons were imported, but that since that time, the consumption has fallen off very materially, and that for the last ten years, the average has probably been not much more than 50 tons, or certainly below 100 tons per annum; this small consumption is, however, merely due to the small amount of fibre which comes into the market, and its present high price.

Messrs. Mark Dawson & Sons have kindly sent me a few specimens of the applications of China grass to manufactures, and these, as well as some specimens of Indian grown rhea prepared by different processes, are now shown here.

The first idea which occurs to one, after a survey of these new trade productions of India, which have in a few years become of such great importance, is, that they afford another proof of the immense latent productive force of India; in fact, they show us that when at last, after many patient efforts, any new Indian product has been introduced into the markets of the world, the trade in it is likely to quickly assume vast proportions. India abounds in vegetable products, which are capable of being put to endless uses in modern manufactures, if only they can once be properly got at; while the country seems capable of raising, not only those vegetable productions which are indigenous to it, but also those of nearly every other country of the tropical and sub-tropical zones.

DISCUSSION.

Sir **Joseph Fayrer**, K.C.S.I., F.R.S., said he had been much interested in the paper, and quite concurred in the concluding paragraph, that the experiments therein narrated showed how great the resources of India were, and what might be hoped for, if proper efforts were made to develop them. He had no special knowledge of any of the subjects referred to, though he took a deep interest in them all, having watched their progress; but perhaps the one which most directly concerned him was the question of cinchona, and he was glad to have an opportunity of paying some small tribute to the great benefit which had been conferred on India by that eminent man of science whose name had been alluded to — Mr. Clements Markham. What the Jesuits did towards the close of the 17th century for Europe generally, Mr. Markham had done for India in introducing the cinchona tree. Its cultivation, and the great development which it had now attained, was due to many others, who took up what Mr. Markham initiated, and the names of Dr. Anderson, Mr. McIvor, Mr. Wood, and Mr. Broughton, must not be forgotten. He especially desired to allude, in terms of the highest commendation, to the efforts of Dr. King, the present superintendent of the Botanical Gardens in Calcutta, and his assistants. Mention should also be made of services rendered by that eminent chemist and quinologist, Dr. De Vrij, of the Hague, who had done much to assist in the elaboration of the preparation which was daily becoming better known and more used under the name of quinetum, the mixed alkaloids produced by the different cinchona plants. It was only after some time that it was discovered that some of these plants were better than others, and it turned out that whilst some produced quinine in sufficient quantity, others did not, but that these produced other alkaloids, which, being prepared in a mixed form, were found to be much less costly than quinine, and at the same time to be a most valuable drug. Certain objections were made at first to quinetum, because it produced nausea, but he believed all these difficulties were passing away. It was a most valuable febrifuge, nearly as good as quinine, for some forms of malarial disease quite as good, and he believed it would, to a great extent, replace quinine, and would place at the disposal of the large population of India a remedy which would be easily accessible, thanks to Dr. King and the Government of India, under whose fostering care it had been developed. He hoped similar assistance would be extended to the other industries which had been alluded to, which had not yet succeeded, but no doubt eventually would succeed, especially the rhea fibre. In India all these things required, at first, Government support, but once fairly started, many of them had shown how capable they were of sustaining themselves. The cinchona plantations near Madras, in South India, and those on the lower ranges of the Himalayas, at Darjeeling, were now perfectly capable of sustaining themselves, and he was glad to find that it was no longer necessary to buy large quantities of quinine at a high price for export to India. It could be made in India, and he hoped the time was not far distant when, not only the mixed alkaloids, but the pure sulphate of quinine itself, would be produced in sufficient quantities to supply the whole of India, and other countries as well. He was under the impression that last year, or the year before, so large a quantity of these mixed alkaloids was prepared, that not only were they able to supply the whole of the Bombay, Bengal, and Madras Presidencies, but also to supply some to merchants in India for use and export. He believed the resources of India were practically inexhaustible, and that under encouragement from the Government, and the eminent men who had the supervision of the produce of India, there was every hope that they would develop still further, and that all these great industries would extend. Tea was now being supplied to the whole of Europe, and it seemed perfectly absurd to send things home from India to be prepared, and then send them back again, or to send things from other countries to India, which she could quite as well produce for herself. With regard to silk, he might mention that there were living specimens in the Zoological-gardens, Regent's-park, of most of the silk-producing worms, in which their various stages could be seen.

Mr. WARDLE was very glad to have an opportunity of adding his testimony to the value of Mr. Royle's paper, especially that part of it which related to silk. He had treated the subject very accurately indeed, and made some valuable suggestions with regard to the future use of wild silk. With regard to the mulberry silks, it must be a matter of great regret, both to the Government and the people of the country, that these mulberry silks of India had not been so largely used of late as they were, and as they deserved to be. It was very difficult to explain all the causes of this, but he believed one of the principal causes was the imperfect reeling of silk from the cocoon in India. Some years ago, the Government made efforts to introduce good reeling appliances, but the results had not been as good as they should have been. The Bengal silk was of the most excellent fibre, beautifully fine, and glossy, and capable of doing equal work to the best Italian silk, provided it was properly reeled.

The CHAIRMAN asked if the experiments had not been tried in India, of having reelers from Italy.

Mr. WARDLE said there were such experiments a good many years ago, a reference to which would be found in one of the Blue-books. India could easily produce as much silk as England, and almost all Europe needed, without having to go to China and Japan, and he was sure that any stimulus that could be given towards the reeling of mulberry silks, would be attended with great benefit. As an instance of what might be done with them, he might mention that Mr. Lister, of Manningham, near Bradford, told him a short time ago, that he had a large investment in India, having 2,000 to 3,000 acres of land in Assam, where he had an extensive staff of persons skilled in cultivating silk. One of his first objects was to cultivate the wild silks, but he found great difficulties, and they did not prove as cultivatable as he had expected. He then turned his attention to the cultivation of the mulberry silkworm, and about 1,000 acres of the land being not suitable for silk growing, he converted them into a tea plantation; and on the rest he set himself zealously to work to cultivate mulberry silk. He had the best reeling appliances known in Europe, and found he could reel the silk more cheaply there by native labour than by sending it over here. He (Mr. Wardle) knew the silk well, and it seemed all that could be desired, and he understood that the produce was so great, that this year Mr. Lister was not only able to supply all his own requirements, but would have about 150,000 lbs. to dispose of. If this could be done in Assam, it showed how much might be done in Bengal by similar energy. With regard to the wild silks of India, it was Sir George Birdwood who first brought the subject forward, and he thought his hopes now stood a fair chance of being realised. He did not think the proper way to look at it was that in which it had been looked upon by a great many European manufacturers who had been accustomed to use the finer silks, and who unsuccessfully tried to substitute the wild silk for them. He did not think it would ever take their place, any more than silver would take the place of gold, but it had uses of its own. He had no idea when he first undertook this interesting investigation that this wild silk was as good as it turned out to be. He believed that if the natives could be taught to reel it in the proper way, many prejudices against it would disappear, and that it would be largely used for a variety of purposes (especially when it could be produced more cheaply) for which cotton and wool were now used. There was great difficulty in obtaining a sufficient supply of the Tussah silk from India. Whether it was owing to the supineness of the natives, or from religious prejudices or what it was, they did not seem to be alive to the increased demand, and were at the present time unable to supply it, and he was much afraid that their Chinese rivals would take the trade out of their hands. He believed the time was coming when this silk would be much more largely used than it had been. Since the Paris Exhibition, the increase had been at least tenfold. If it proved so beautiful for the purpose of embroidery as to attract the notice of her Majesty and the Princesses, and also very general public attention, there was no reason why it should not be used also for other pnrposes, especially now that the dyeing difficulties had been overcome. With regard to the bleaching of this silk, there was a card on the table showing various shades of it, from the natural dark fawn colour, which was No. 1, to almost pure white. No. 1 would take no dye. The simplest mode of cleaning it was by soda and soap, the result of which was shown in the second specimen, which would take certain colours very well. In No. 3 specimen he had added to the first process a solution of sulphate of soda. The fourth was still better, and gave a fair range of lighter shades; that was done with permanganate of potash. When that process was first tried, it rotted the silk, but he found when using it with judgment, there was little to be feared in that way; little that did not enable them to use some of the pale shades shown in the centre of the card. The next plan was what Mr. Royle mentioned, the process of Mr. Tessier de Motay, binoxide of barium. He had found that work fairly well, the principal objection being its expense, and it was therefore used very littie indeed. Latterly he had been experimenting with peroxide of hydrogen, and he found that gave a whiter shade to the silk than any of the other agents, the result being shown in No. 6. The silk was simply immersed in the solution for a night, or more. Unfortunately, peroxide of hydrogen was expensive, but it was to be hoped that chemists might discover some cheaper mode of producing it, and if this could be done, it would be used to a larger extent, and it would enable them to dye the finest shades of colour. A good deal of attention was being paid to this silk on the Continent, and during the last year he had received many letters from M. Rondó, of Paris, who was president of the silk jury at the Paris Exhibition. He had been writing a book on the consumption and use of silk, and told him he had just finished his investigations in wild silk, which was not making so much progress in France as he hoped, because it came so badly reeled that manufacturers could not substitute it for other silk. He thought that was the blunder all along, trying to substitute this for other silk, instead of finding a use for it *per se*. The Germans were beginning to find this out. A dyer in Germany, to whom he gave the process of bleaching, some time ago, recently informed him that one of his customers was using as much as 1,000 kilos. a week, and another was using nearly as much, but he said the Germans had discarded its use entirely, except for making plush. It was so suitable for this purpose, that it was really wasting time to attempt to do anything else with it. A specimen of this material was on the table.

The CHAIRMAN said he had recently been much interested in hearing of some experiments made in regard to rhea fibre by Mr. Sebastian Anderson, and should be glad if he could give any information with regard to the process.

Mr. ANDERSON said it was a secret of his own, and he must, therefore, ask to be excused explaining it.

Mr. THOMAS CHRISTY having recently seen Mr. Ekman's process for the treatment of fibres of different grasses, he wished to say that he thought the principal thing to be aimed at was to prepare the fibre for the manufacturers in its normal form, in the same way as cotton as it came from the pod. There were thousands of acres in India yielding the Nilgherri nettle, which was only slightly used by the natives, and by the process of merely boiling in a lead-lined cylinder, with a chemical solution, it yielded its fibre at once. Then came the question whether the manufacturers would accept the fibre in the form of filaments, or as normal fibre. By this boiling process, it was only a question of time to bring it out in that form. This had been set at rest within the last three or four months, with regard to American fibres. Mr. Ekman was now in America, having been asked to go there to start the process fairly, but he would shortly be back in England. He had thoroughly succeeded to the satisfaction of the American manufacturers. He understood the process had been shown to several gentlemen connected with India, and they seemed perfectly satisfied. One gentleman asked to see the effect on a cocoa-nut; it was put in a cylinder, and in one hour it entirely freed the whole of the pulpy residue, and as soon as it was cool, the whole of the threads or fibres were taken away. It was only an ordinary cocoa-nut husk, but it came away very light, and it was pronounced to be of very good quality, none of the fibre being bruised or broken in any way. The same process could be adopted for many Indian fibres, and it was simply a question to what degree it should be carried. He thought no discouragement should be thrown on any process. The field was so enormously vast, that if anyone came forward with a process, he should be supported, and in a short time it would be found which was most advantageous. Within the last week, it had been found that the farmers of England could plant flax in fields, and that it could be taken from the field as soon as it was ripe, placed in a cylinder, and the produce which came from it had been valued by people in the trade at £100 a ton.

Mr. E. KIMBER understood there was a new process, by which after the flax assumed its normal condition, it was submitted to another treatment whereby all the silex was taken from it, so that the cold feeling usually belonging to linen sheets was entirely destroyed, and the fabric made as soft as silk, and almost as durable. This process, he believed, was under the consideration of some of her Majesty's Ministers, and was being submitted to a combination of gentlemen in Belfast. He should like to hear some further details with regard to the expense of planting cinchona; how long it took for the plants to come to maturity, and so on; and the same with regard to introducing mulberry cultivation.

The CHAIRMAN said he feared these details could not be given, as Mr. Royle was not present. He had been much interested in the paper, and was entirely of Sir Joseph Fayrer's opinion, that the resources of India were as yet by no means fully appreciated. Commercially speaking, he considered India to be still in its infancy. Her trade scarcely exceeded 10s. per head of the population, and was susceptible of very great increase. In his friend Sir John Strachey's book a statement was given of the progress of India during the last 40 years, which was very encouraging. He said the rate of increase due to what might be considered natural causes was three millions in the ten years between 1841 and 1851, but when railways had begun, the decennial increase rose to 12 millions from 1851 to 1861, a further 11 millions in 1861 to 1871, and a further 18 millions in 1871 to 1881. This was a very hopeful feature indeed as it showed what the increase of railways throughout the country would do for the trade of India. He had always been an advocate for the improvement of agriculture in India, though, in some quarters for a long time, this met with very little support, and they were told the natives of India knew quite as much as we could show them, and it was time thrown away in endeavouring to teach the natives agriculture; but he was glad to say that of late the subject had attracted a great deal of attention, and the Government was now creating departments of agriculture in different parts of India, It must be borne in mind that the people of India never took the initiative in anything; they were eminently conservative; the son was content to tread in the footsteps of his father. It was under the fostering care of the Government, or under the guidance of European enterprise that the condition of India was improved. They had heard what had been done with tea, but there were other things which had made progress quite as wonderful; wheat for instance. A few years ago our imports of wheat were only 300,000 pounds inthe year; last year it was between three and four millions. He had inspected a great many samples sent home by desire of the Government, with the assistance of one of the best brokers in the City of London, and the result was so satisfactory, that it quite surprised both Sir John Strachey and himself. Some of the wheat was of the finest description—as fine as that from Adelaide, which had hitherto held about the very highest place in the market. The quantity was also increasing; as railways increased, this trade would become a very large one indeed, and would make England independent of those countries to which she had now to look for the supplies of this necessary article of food. Jute, he was afraid, was threatened with severe competition from America, where he understood it was grown more scientifically than in India, and of better quality; but there were other articles which he was certain would be developed in course of time. The great want of India was railroads, and communications of all kinds. Coal-fields, corn-fields, or other fields, were not of much value if they were 200 or 300 miles away from any railroad. Cheap transit was at the foundation of all commercial prosperity, and it was only as railroads pushed through those parts of India where they did not exist at present that they could hope to see the trade of the country improve. The present Government was certainly alive to this fact, and was doing all it could to push forward these matters. With regard to opium, they had been threatened on the one hand with increased production in China and Persia, and on the other, with its extinction by opposing agitators, but he thought it would be very long before the opium of India would lose its hold on the markets of the world. It was the finest produced, and if people would use opium—and he did not believe it had all the injurious effects attributed to it—they would go to India for it. There had been a great deal said about it, but he began to hope the agitation was dying out, for it really was not founded on common sense. In conclusion, he begged to propose a vote of thanks to Mr. Royle, who, he much regretted, was not able to be present that evening.

Mr. MARTIN WOOD begged leave to second the motion, saying it was extremely interesting to have such a paper prepared by Mr. Royle, when they knew how much India owed to his father, Dr. Forbes Royle. He would suggest that the specimens of silk now shown might be allowed to remain in the Society's rooms for some time for inspection, and that there should be left with them some sort of explanation of the processes employed in bleaching and dyeing, as had been described by Mr. Wardle. His own knowledge of these matters was necessarily theoretical, but in connection with the journals he had written in for many years, in India, he had constantly directed attention to the fibres of India, with the object of trying to bridge over the last step which always was the difficulty—the step between the knowledge of these products, and the treatment of them, and that of bringing them within the reach of commercial agencies. It was to this point that attention should be devoted both by this Society and the Government. To take the typical instance of silk produced by the hybrid worms which Mr. Royle had referred to; since he (Mr. Wood) had last referred to that subject, he found that a project had been devised for producing the silk, but the inventor was still waiting for the necessary capital. A very small sum would do, say £2,000; though £6,000 or £10,000 would be better, and it seemed an extraordinary thing that a few men in the silk trade could not club together and provide this amount. This projector was a good inventor, but not an organiser. Other subjects had been mentioned that evening, in which a few thousand pounds would suffice to give the start, and bridge over the gap which prevented the thing going forward. With regard to the rhea machines, he had followed the trials as closely as he could at the time, and while he did not say Mr. Greig had not fair play, he thought the conditions of the competition were impracticable. What should be aimed at in this matter, was a process which should approach the Chinese mode of manipulation. Several gentlemen had mentioned simple processes which had been invented, and he remembered that Mr. Cruikshanks, telegraph manager on board the *Great Eastern*, when he was in Bombay, invented a very simple process for dealing not only with rhea, but with aloe fibres. He had no inducement to go on with it, but he left some directions there, which had been lost sight of. He mentioned this, in order that if the details were accessible now, the necessary information might be obtained.

Obituary.

JOHN SCOTT RUSSELL, F.R.S.—By the death of Mr. Scott Russell, the eminent naval architect, at Ventnor, on Thursday, 8th inst., the Society of Arts loses an old member, and a former Secretary who held office during five important years of the Society's history. Mr. Russell was originally elected a member on November 20th, 1844, and took an active part in the deliberations of the Committee of Miscellaneous Matters, which at that period, before the Council was appointed, had the chief management of the Society's affairs. In July, 1845, he was appointed joint Secretary with Mr. Whishaw, and subsequently he became sole Secretary. At the time of his election action was being taken for the purpose of arranging a series of national Exhibitions, and it was during his Secretaryship that the Society was incorporated by Royal Charter. Out of the national Exhibitions grew the idea of an International Exhibition, which was carried out in 1851, under the auspices of H. R. H. the late Prince Consort, President of the Society. In arranging the various steps by which this great undertaking was brought to a successful issue, Mr. Russell took a prominent part; and in January, 1850, when a Royal Commission for the promotion of the Exhibition was appointed, he was appointed joint Secretary, with Mr. (now Sir Stafford) Northcote. Shortly after this he resigned the office of Secretary of the Society, and was placed on the Council at the next annual meeting. In 1854, he was elected a Vice-President. Mr. Russell was born in the year 1808, and was, therefore, 36 years of age when he came from Scotland to London, and joined the Society of Arts. He had then attained some distinction, both as a scientific man and as a naval architect. In 1832, he had been selected to fill the temporary vacancy in the Professorship, on the occasion of the death of Sir John Leslie, Professor of Natural Philosophy at Edinburgh University. Soon afterwards, he commenced his life-long researches on the nature of waves, and his first paper on the subject was read before the British Association in 1835. Two years later, he received the gold medal of the Royal Society of Edinburgh, for a paper on "The Laws by which Water opposes resistance to the motion of Floating Bodies." He was employed for several years as manager of the shipbuilding establishment at Greenock, now belonging to Messrs. Caird & Co., and during this time he designed and built several large vessels, on the system laid down by himself. Mr. Russell was elected a Fellow of the Royal Society in 1849, and in 1860 he built the *Great Eastern*, which was the great work of his life, and that by which his name will probably be longest remembered. He was one of the founders of the Institute of Naval Architects, and contributed no less than twenty-one papers to the Transactions of that Society. One of these was on "International Communication by Railway Steamships;" and to show how much this subject interested him, it may be added that his last work of naval construction was the steamer on the Lake of Constance, which carries railway trains between the termini of the German and Swiss railway systems on the opposite shores of the lake. Although he was first of all a naval architect, he did not confine his energies to that branch of engineering. In early life he constructed steam carriages for common roads, which ran between Paisley and Glasgow. He was greatly interested in the question of technical education, and, in 1859 he delivered a lecture at the South Kensington Museum, which he entitled, "What Should Mechanical Workmen be Taught?" In 1869, he published a work on "Systematic Technical Education for the English People." Mr. Russell was a frequent attendant at the meetings of the Society of Arts, and those who have heard him speak will not soon forget his original and racy manner; but some time back he was seriously injured by an accident, from the effects of which he never recovered.

General Notes.

South Kensington Museum.—A collection of objects illustrating the Scandinavian industrial arts has been sent over to the South Kensington Museum, and is now being exhibited there. They have been selected as characteristic of the Scandinavian style, in ancient and modern times. The collection includes richly decorated weapons and personal ornaments, dating from the earliest period, as well as a series of examples of later date, down to the present time, The exhibition also contains a series of silver filagree ornaments belonging to the dress of the peasants in the Scandinavian countries and Iceland, skilfully carved coffrets, drinking cups, and other wood-work, and a rich collection of textiles and needlework.

Society of Telegraph Engineers and of Electricians.—The Council of this Society offer three premiums annually, for the best original paper sent in to the society, on telegraphic or electrical subjects, during the session, by any person not being a member of the council of the Society. The first premium to be called the Society's Premium, value £10; the second to be called the Paris Electrical Exhibition Premium, value £5; the third to be called the Fahie Premium, value £5. The premiums will consist of books or scientific apparatus, and no person will be entitled to receive more than one of the said premiums in any one year. The first premiums will be awarded in 1883, for the best papers sent in between this date and the end of May next.

Brazilian Coffee.—Of all the coffee-producing countries, the Empire of Brazil takes the lead, the amount produced there last year having been 5,357,143 cwts., or about half the world's consumption, which is estimated at about 500,000 tons. Out of the 5,000,000 bags (of 120 lbs. each) grown there, half goes to the United States, the Americans drinking more coffee than almost any other nation, and the other half is sent to Europe. The United Kingdom now takes about 270,000 cwts., and the Brazilian planters, in face of the large amount of adulterated coffee sold here, are endeavouring to extend the sale of their produce in England. The planters, under the combination of the Central Association of Agriculture and Commerce of Rio Janeiro, and under the the auspices of the Imperial Government, have sent samples of the coffees from all the provinces of Brazil, with views, statistics, and details, to be shown at the Crystal Palace; and this exhibition was inaugurated lately, by an official dinner, given there by the Consul-General to the Brazilian Ambassador and the Countess Pinedo, and the *personnel* and staff of the Embassy, Consulate, and distinguished Brazilian gentlemen.

MEETINGS FOR THE ENSUING WEEK.

Tuesday, June 20... Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Dr. William A. Guy, "Two Hundred and Fifty Years of Small-Pox in London."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Menagerie in May." 2. Prof. E. Ray Lankester, "The Valves of the Heart of *Ornithorhynchus paradoxus* compared with those of Man and the Rabbit, with some observations on the *Fossa ovalis.*" 3. Prof. Huxley, "The Respiratory Organs of *Apteryx.*" 4. Mr. W. A. Forbes, "Contributions to the Anatomy of Passerine Birds. Part VI. *Xenicus* and *Acanthisitta* as types of a new Family (Xenicidæ) of Mesomyodian Passeres from New Zealand."

Wednesday, June 21....Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Rev. Fenwick W. Stow, "A New Metal Screen for Thermometers." 2. Dr. David Gill, "The Effect of Different Kinds of Thermometer Cribs, and of Different Exposures, in estimating the Diurnal Range of Temperature at the Royal Observatory, Cape of Good Hope." 3. Mr. Charles S. Hudson, "Account of a Cyclone in the Mozambique Channel, January 14th-19th, 1880." 4. Mr. R. H. Twigg, "Rainfall of Frere Town, Mombassa, East Coast of Africa, 1875-81."

Royal Botanic, Regent's-park, N.W., 8 p.m. Evening Fête.

Thursday, June 22...Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Bernhardt, "The Philosophy of Music."

Friday, June 23....Royal United Service Institute, Whitehall-yard, 3 p.m. Major J. C. Ardagh, "The New Greek Frontier."

Browning Society, University College, W.C., 8 p.m. Professor Corson, "Browning Method of Revealing the Soul to Itself, by means of a Startling Experience."

Journal of the Society of Arts.

No. 1,544. Vol. XXX.

FRIDAY, JUNE 23, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Twenty-eighth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Members, will be held, in accordance with the Bye-laws, on Wednesday, the 28th of June, at 4 p.m.

(By order of the Council)
H. Trueman Wood,
Secretary.

UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Association of Science and Art (late Liverpool Student Association), Liverpool.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, assisted by W. A. Barrett, Mus. Bac. Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 10th July, 1882.

Honours.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

First and Second-class.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

The fee is 10s. for the Honours (including both vocal and instrumental Examination), and 5s. for the First or Second-class (vocal or instrumental) Examination. If vocal as well as instrumental music, or two separate instruments, be taken by the same condidate for the First or Second-class Certificate, a fee of 7s. 6d. must be paid.

The examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of the Society of Arts' Committee.

No list of Candidates will be published.

Full particulars can be obtained on application to the Secretary.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Exhibition was opened on Wednesday, 24th ult., and will remain open (every day from 10 to 4, Saturday 10 to 2) until Friday, 30th inst. Members of the Society are admitted on signing their names, and can admit friends either by use of the tickets supplied for the evening meetings and lectures, or of their visiting cards.

A catalogue of the Exhibition was given in the number of the *Journal* for May 26th.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE, FOR THE YEAR ENDING MAY 31ST, 1882.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1881	753	2	5			
Do. in hands of Secretary	16	2	9			
				769	5	2
,, Subscriptions received during the year from Members and Institutions in Union	6,169	4	6			
,, Life Compositions	651	0	0			
				6,820	4	6
,, Dividends and Interest				656	6	1
,, Sale of 2,500 dols. United States 5 per Cent. Bonds (Howard Trust), sold out for re-investment	528	2	6			
,, Do. £343 14s. 3d. Metropolitan 3½ per Cent. Stock (Memorial Window Fund)	371	12	11			
				899	15	5
,, Bequest from the late Edward Bax (£100 less legacy duty)				90	0	0
,, Examination Fees				87	10	6
,, House and Office (receipts for gas, &c.)				38	10	0
,, Advertisements				1,393	16	0
,, Sales—						
Barry's Etchings	10	10	0			
Cantor Lectures	19	8	3			
Domestic Economy Reports and admissions to Congress, 1881	57	9	5			
Journal	129	15	9			
Patent Bill	1	0	9			
Photographic Exhibition Catalogues	6	15	6			
Public Health Conference Reports	2	2	9			
Spoiled Post-cards	2	18	4			
Transactions	1	7	6			
				231	8	3
				£10,986	15	11

Cr.

	£	s.	d.	£	s.	d.
By House and Premises:—						
Rent, Rates, and Taxes	335	13	4			
Insurance, Gas, Coal, House expenses, and expenses incidental to ordinary meetings	285	17	3			
Repairs and Alterations	138	14	4			
				760	4	11
,, Office:—						
Salaries and Wages	1,850	19	9			
Stationery, Office Printing, and Lithography	327	6	11			
Advertising	56	13	0			
Postage Stamps, Messengers' Fares, and Parcels	200	19	5			
				2,435	19	1
,, Library, Bookbinding, &c.				66	12	6
,, Conversazione				225	8	2
,, *Journal*, including Printing, Stamps, and Distribution				2,131	11	3
,, Advertisements (Agents and Printing)				509	0	9
,, Examinations				263	1	3
,, Conference on Domestic Economy, 1882				316	18	5
,, Medals:—						
Albert (1881)	22	18	0			
Society's	17	12	0			
				40	10	0
,, Owen Jones Prizes				20	11	0
,, Cantor Lectures				274	2	9
,, Juvenile Lectures				39	7	3
,, Sections:—						
Applied Chemistry and Physics	69	10	9			
Foreign and Colonial	61	6	4			
Indian	60	18	4			
				191	15	5
,, Committees:—						
Education Code	15	1	11			
Food	1	10	9			
Memorial Tablets	5	3	9			
Musical Education	2	7	6			
Patent Bill	176	4	0			
Plant Labels	2	7	4			
General expenses	13	2	3			
				215	17	6
,, Repairs to Dr. Swiney's Tomb				4	0	6
,, Memorial Window in St. Paul's:—						
F. W. Moody, for design	50	0	0			
Power of Attorney for Sale of Stock	0	11	6			
Balance of Fund paid over to the Dean and Chapter of St. Paul's, after deducting £10 paid in 1876 for original design	311	1	5			
				361	12	11
,, Exhibitions:—						
Art Workmanship	85	5	10			
Photographic	78	5	5			
Pottery	0	16	0			
				164	7	3
,, Annuity to Mrs. Cantor	25	0	0			
,, ,, ,, Mrs. Le Neve Foster	100	0	0			
				125	0	0
,, Investment of Life Compositions (£651) in purchase of £646 17s. 7d. Reduced 3 per Cent. Stock	651	0	0			
,, Do. Howard Trust (£500) in purchase of £500 Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0			
,, Do. Bequest by the late Edward Bax (£90), and repayment to capital of £404 7s. 6d., part of sum sold out in 1876 for current expenses, in purchase of £500 Queensland 4 per Cent. Stock	494	7	6			
				1,645	7	6
				£9,791	8	5
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1882 1,223 18 11						
Less by cheque uncashed 40 0 0						
	1,183	18	11			
,, Ditto in hands of Secretary	11	8	7			
				1,195	7	6
				£10,986	15	11

LIABILITIES.

	£	s.	d.	£	s.	d.
To Tradesmen's Bills	543	9	7			
,, Rates	43	15	0			
,, Examiners' Fees	49	7	0			
,, Examination Prizes	48	0	0			
,, Sir Walter Trevelyan's Prize	100	0	0			
,, Sections:—Foreign and Colonial, Applied Chemistry, and Indian	170	0	0			
				954	11	7
Excess of Assets over Liabilities				9,954	18	4
				£10,909	9	11

ASSETS.

	£	s.	d.	£	s.	d.
By Society's Funds invested in—						
Reduced 3 per Cent. Stock, £5,401 5s. 2d., worth on 31st May, 1882, £5,427 5s. 3d., less £665 2s. 3d., reserved to meet Trusts Nos. 6, 7, and 8, stated below	4,762	3	0			
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, worth on 31st May, 1882	232	3	10			
£500 Queensland 4 per Cent. Stock, worth on 31st May, 1882	510	0	0			
				5,504	6	10
,, Subscriptions of the year uncollected	657	6	0			
,, Arrears, estimated as recoverable	300	0	0			
				957	6	0
,, Property of the Society, including Barry's Pictures and Lease				2,000	0	0
,, Advertisements on the Books due and in course of execution*				1,152	9	7
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1882	1,223	18	11			
Less by cheque uncashed	40	0	0			
				1,183	18	11
,, Ditto on Deposit				100	0	0
,, Ditto in hands of Secretary				11	8	7
				£10,909	9	11

* A portion of this sum is liable to charges for printing.

STOCKS AND CASH STANDING IN THE NAME OF THE SOCIETY.

Consols	£4,891	6	4
New 3 per Cents	388	1	4
Reduced 3 per Cents	5,401	5	2
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150	0	0
Bombay and Baroda do. do.	2,450	0	0
Canada 4 per Cents	423	0	0
India 4 per Cents	105	18	7
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Stock	500	0	0
Cash on deposit with Messrs. Coutts and Co.	100	0	0

TRUST FUNDS INCLUDED IN THE ABOVE.

1.	Dr. Swiney's Bequest	£4,500	0	0	Consols, chargeable with a sum of £200 once in five years.
2.	John Stock's Trust	100	0	0	,, ,, the Award of a Medal.
3.	Benjamin Shaw's Trust for Industrial Hygiène Prize	133	6	8	,, ,, ,, Interest as a Money Prize.
4.	North London Exhibition Trust	157	19	8	,, ,, ,, ,, ,, ,,
5.	Fothergill's Trust	388	1	4	New 3 per Cents, chargeable with the Award of a Medal.
6.	J. Murray, in aid of a Building Fund	50	0	0	Invested in Reduced 3 per Cent. Stock.
7.	Subscriptions to an Endowment Fund	525	2	3	
8.	Dr. Aldred's Bequest	90	0	0	
9.	Thomas Howard's Bequest	500	0	0	,, Metropolitan Railway 4 per Cent. Perpetual Preference Stock.
10.	Dr. Cantor's Bequest	5,052	19	8	,, Bombay and Baroda and Oude and Rohilcund Guaranteed Railway Stock.
11.	Owen Jones Memorial Trust	400	0	0	,, Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12.	Mulready Trust	109	12	9	,, India 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,800	0	0	,, Great Indian Peninsula 4 per Cent. Guaranteed Railway Debenture Stock.
14.	Sir Walter Trevelyan's Prize	100	0	0	On Deposit with Messrs. Coutts and Co.

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.

The Payments set forth above have been made by authority of the Council.

The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

B. FRANCIS COBB, } *Treasurers.*
OWEN ROBERTS, }
J. OLDFIELD CHADWICK, F.C.A., *Auditor.*

H. TRUEMAN WOOD, *Secretary.*
Society's House, Adelphi, 16th June, 1882.

Proceedings of the Society

EXTRA MEETING.

Tuesday, April 4th; Dr. R. J. MANN, F.R.C.S., in the chair.

The lecture delivered was on—

THE ATTITUDES OF ANIMALS IN MOTION.

By MR. MUYBRIDGE.

GENTLEMEN—The honour which has been conferred upon me scarcely exceeds the pleasure I feel in coming before you this evening, but I think you will agree with me, that it will be unadvisable to detain you by a long lecture on animal mechanism. I think you will prefer seeing the result of my investigations to hearing a discourse on anatomy and physiology.

The attempts to depict the attitudes of animals in motion probably originated with art itself, if, indeed, it was not the origin of art; and upon the walls of the ancient temples of Egypt we still find pictures of, perhaps, the very earliest attempts to illustrate animal motion. But artists of all ages seem to have followed peculiar grooves in this matter, and to have adopted uniform notions as to the movement of animals. How inaccurate these notions have been, I shall endeavour to demonstrate to you this evening. I will commence, however, by showing you the apparatus by which the photographs were made; you will then better understand the pictures themselves. Here is the apparatus, consisting of an ordinary camera, in front of which is a strong framework, enclosing a couple of panels, each with an opening in the centre, sliding, one up and one down. In connexion with it is an electro magnet, which, on completion of a circuit of electricity, causes a hammer to strike and release a catch which holds the shutters in position; the back shutter is then drawn upwards by a strong india-rubber spring, and the front shutter is simultaneously drawn downwards. Here is a photograph of three shutters in position, one showing the panels before exposure, one during exposure, and a third after exposure. The next picture shows the arrangement in front of the cameras. Here are a series of strong threads stretched across the track, each of which being pressed forward, causes two metal springs to touch, and thereby completes the electric circuit. These threads are arranged at a distance of 12 in. from each other, and as the horse passes along he thrusts the strings, one after the other, completes an electric circuit, which operates the shutter of the particular camera which he is passing at the moment.

Twenty-four cameras are arranged parallel with the direction of the animal. The next picture shows the entire photographic arrangements. The track is covered with india-rubber, to prevent dust flying from the horse's hoofs; and there are here five cameras arranged in a semicircle, the object of which I will explain presently. The result is this:—A horse, in his progress over the track, comes in contact with these threads successively, and is photographed in the position in which he happens to be when he strikes the thread; then he moves 12 inches, and of course assumes another position, and is so photographed, then another 12 inches, and so on; in this way we have several positions assumed by an animal during an entire stride. The time of exposure, I may say, is the $\frac{1}{5000}$ of a second.

Here is a scale I have drawn out, but which it would take me nearly an hour to explain, illustrating the position of a horse's feet during the various strides, the walk, the trot, the gallop, and the pace; if any one feels sufficient interest in the subject to inquire more thoroughly into it by-and-by, it will afford me a great deal of pleasure to explain it.

Now, as I have spoken of the faults of artists, I must show you what those faults are. Here are some pictures of horses walking, from different sources, with some of which you are all no doubt familiar. One is from Egypt, where they seem to have had two modes only of illustrating the motion of an animal, one the walk, the other the gallop. Here is one walking, with all four feet on the ground at once. As a general rule, indeed almost always, they are going from left to right. You will notice that the lateral legs are represented as moving synchronously, both left legs touch the ground at the same time, and both right legs. Here are other examples of Assyrian and Greek art; a Roman of the 1st century and one of the 8th century, also a Norman horse from the Bayeux tapestry, a German horse, and one by Flaxman, which is the only correct one of the series. I would particularly call your attention to a representation from the column of Theodosius, where you see two mules, in one of which the hind legs are precisely in the same position as those of the mule in the next illustration, whilst the fore legs are totally different. Now, a mule or a horse always walks in the same way, so that if one is right the other must be wrong.

Here are photographs of a horse in the act of walking. A horse, while walking, is alternately supported on three feet and on two, and the two are alternately diagonals and laterals. Some very eminent authorities have asserted that a horse, while walking, has never more than two feet on the ground at the same time; but he has always two—that is the characteristic of the walk—and invariably three, four times during each stride, two hind legs and a fore leg, alternately with two fore legs and a hind leg. This horse, you observe, is standing on the right laterals. The most common fault of artists in representing the walk is to mistake the laterals for the diagonals: it arises, I am satisfied, from carelessness and lack of observation. Whenever a horse or any other animal has two suspended feet between two supporting legs, those two suspended feet are laterals, never diagonals. You find them in pictures, engravings, and even in sculpture, quite as frequently represented one way as the other; but they are invariably laterals—that is, when they are suspended *between* two supporting legs. When supported on diagonals, suspended feet are outside the supporting legs. Here is a horse walking, photographed simultaneously from five different points of views, according to the arrangement of the cameras I referred to just now. Next, we have a photograph showing the regular series of positions taken by a horse while walking. Of course, in every thousandth part of an inch, a horse really gets into a different position, but these are all the positions of a stride which are worth illustrating.

Next we have the amble; and first I show you some specimens of Egyptian, Assyrian, Etruscan, and Modern Italian art. They are none quite correct, but they approach more nearly to the gait which is ordinarily called the amble than any others I have found. I do not know whether this gait is properly understood or appreciated in this country, because horses are not trained to it, but Spanish horses are invariably taught it. It is faster than a walk, but not quite so fast as a trot, and is an easy, sliding motion, alternately on one foot and on two feet. In this, as in the walk, the horse is never entirely off the ground; in all other gaits the weight is off the ground entirely during a portion of the stride, but in these two he is never clear of the ground. He is alternately on one hind foot, then on two laterals, then upon one fore foot, then on the diagonals, then on a hind foot again. The succession is very curious: first on one foot, then on two; the two feet being alternately diagonals and laterals.

When these photographs were first made, some experts had doubts as to their accuracy. We have here a little instrument called the zoöpraxiscope, with which we can throw the various positions in rapid succession on the same spot on the screen, and thus produce apparently the real motion, and you will readily understand that if any of the positions were incorrect, it would upset the experiment altogether.

Next we come to the trot, and as before, I first show you some examples of ancient and modern art. There is Marcus Aurelius on horseback, but that is not a real trot, because in a trot the motion of the diagonals is more synchronous than is here represented. The best example of a trot I have been able to discover of mediæval times is from a stained glass window in the Cathedral of Chartres. There are two from the Louvre, representing Louis XIV. and Louis XV.; none of them are quite correct, but none have such glaring faults as one by a very celebrated artist, Rosa Bonheur. She is, perhaps, one of the greatest artists of modern times; grand in colouring, splendid in drawing, a great observer of nature, but, unfortunately, she did not pay sufficiently strict attention to the positions of animals in motion. This is a very celebrated picture, and the horse is supposed to be trotting pretty fast. Now, one fore leg is extended backwards, really beyond the centre of gravity of the horse. It would be utterly impossible for him to bring it forward in time, at the rate he is going, to support his body, and he would be obliged to fall down—he could not help it.

Here are a series of photographs of a horse trotting at about ten miles an hour, showing all the various positions at the different periods of the stride. Now, to me it seems almost incomprehensible, but until these experiments were made, it was a question with some very experienced horse drivers whether a horse was entirely clear of the ground during a trot. Some imagined that he always had one foot on the ground, though I cannot see how it was possible for them to come to that conclusion. Even at a moderate rate, in trotting, the weight of the body is entirely unsupported by the feet, though they may drag along the ground at a certain portion of the stride, no matter how slow the pace. This being about ten miles an hour, the horse is entirely clear. Here, again, is a horse trotting at the rate of a mile in 2 min. 20 secs. One thing I would call attention to is this, that when a horse's foot strikes the ground, the leg is always straight; it is never in a bent position. Though you find some eminent artists illustrate a horse striking the ground with his leg bent, it simply is not possible. Another thing is, that he always strikes the ground with his heel first, never with his toe. Here is another horse performing a moderately fast trot, about 8 miles an hour, and making a stride of 6 ft. 6 in. Here is another trotting very fast—1 mile in 2 min. 18 sec.; the fastest time ever accomplished being a mile in 2 min. 10 secs. There is also a peculiarity observable with regard to the position of the pastern. When striking the ground it is vertical, but it immediately sinks so as to become almost horizontal. Now, we will try the trot with the zoöpraxiscope, and you will find the motion is perfectly produced.

Next we come to the canter, which is rather a peculiar gait. It differs from the gallop in many respects, and notably in this, that whereas in the gallop the horse will leave the ground with the fore feet, as also he does in the canter, in landing in the gallop he lands first on one hind foot and then brings down the other hind foot, so that he will be on two hind feet at the same time, and throwing his fore feet forward; in a canter he will land on one hind foot, and the next foot to touch the ground will be a fore foot; then he will bring down the other hind foot, and then the next fore foot. That is the invariable order of succession in the canter, but the hind foot will follow the fore foot so rapidly that it is utterly impossible for the eye to follow the succession of movements. Here we have a series illustrating the canter. You see he leaves the ground on the fore foot, as is invariably the case with either the canter or the gallop. That is another singular fact that artists have not noticed, and they have been led into the very egregious error of imagining that a horse, while galloping, left the ground with the hind foot and landed on the fore feet. A horse, while galloping, is always in the air for a certain portion of time, but it was always supposed that in galloping he would leave the ground with the hind feet and land with the fore feet, whereas the reverse is always the case.

We now come to the fastest of all gaits—the gallop. Here is the Egyptian representation which, with very slight variations, is the way in which Egyptian horses galloping are always represented; the hind feet are down, and the fore feet in the air. The Assyrian is not much better, but the Greeks evidently understood the motion of a horse better than a great many of the moderns; and this is very nearly the position in which a horse would be, having just landed after a flight through the air. He has struck the ground with his hind feet, one hind foot being behind the other. Here is another from the column of Theodosius; here is a Norman example from the Bayeux tapestry, and here is one by some Italian artist of the 4th century, in which we find a position of the gallop exactly reproduced. Here is one by Albert Durer; this is the conventional gallop; and, with all due deference to the artists who have palmed it off on the public as being a representation of a galloping horse, I must say it is really absurd, because it is utterly impossible for a horse to get into that position. Here are some ancient pictures, one from the ruins of Angar Wat, in Cochin China; a Japanese, which is tolerably correct; and a very curious one, copied from a painting on the rocks on the banks of the Yenisi by the Tartars. This shows how artists of different ages and different countries have all agreed in representing nearly the same conventional position of the gallop.

While on the question of the absurdity of this position, I may remark that where there are ten horses it is a concentrated absurdity—it is ten times as absurd—because if it were possible even for one horse to get into that position, it would be certainly the height of improbability for ten horses, at the same instant of time, all to be in the very same position; yet here is a picture by a distinguished artist, Mr. Herring, a very celebrated painter of horses. He has painted ten horses all fully extended in that conventional position. The public may have demanded that, and he painted that picture in that way. It is necessary that the public and the artist be educated together. Here we see a photograph of a free gallop, with a horse just about alighting on the ground still in the air. When the horse is in the air, it is not with his feet stretched out as far forward as they will go, and the two hindmost in the same way, but they are curled up invariably in the way you see them in this photograph. That horse is now in the air, about to alight on the hind foot. In another one, you see him alighting on the hind feet, and, of course, there are intermediary positions between these; and this where he is about to leave the ground with one forward foot. Those connected with the turf are well aware that, when horses break down, they always break down with the fore feet, and never with the hind feet, or very rarely. It was a mystery why that should be so, but here is the key to it; the immense amount of work that a race-horse has to perform with his fore legs is fully equal, in my judgment, to that with the hind legs. Here are all the important positions which a galloping horse will assume in making a complete stride. In its particular features each stride really differs from another. If you take one of the swiftest race-horses, and measure his stride, you sometimes find one inch, sometimes two, and sometimes half-an-inch variation in the length of the stride; it depends on various little things, but this is a representative stride. Here is another, with a little longer stride—19 ft. 9 in.—in a stride of 25 or 26 feet. We might have information different to that we have obtained.

Now we come to the leap. This is the horse rising preparatory to clearing the hurdle. The hind feet are on the ground for the last time before making the spring, and you notice that one is much in advance of the other—a few inches; sometimes it is more than that. They are hardly ever at precisely equal distances from the hurdle, and on coming down, you find a greater variation. I may say that these pictures are entirely untouched; they are exactly as they were made in the camera; there is no interpolation by any artist, or any imagination. Here the horse is coming down; one fore leg you see is nearly straight, the other is somewhat curved, because he has not had time to bring it out probably; it will be perfectly straight when he touches the ground. Here he is landed, and you notice that one pastern is almost horizontal. That is the position in which a horse invariably strikes the ground. Here we have an entire consecutive series taken from a distance of about twenty feet in front of the hurdle. There is more variation in the leap of the horse than in almost any other movement. Sometimes he will leave the ground at a distance of twelve feet from a hurdle 3 ft. 6 in. high; at other times he may probably not leave the ground until 3, 4, or 5 ft. of the hurdle. It depends a great deal on the disposition of the horse. Here is a series illustrating his position after he has cleared the hurdle, showing the method by which he picks up his feet, and regains the gallop, after having made the jump. This is a complete stride, and we can follow the horse here from the time he leaves the ground with his feet until he lands on his fore feet. I will now illustrate this movement with the zoöpraxiscope. Here are some photographs of the dog. In fact, some people might mistake that for a horse, because the position is somewhat like the conventional horse gallop. The motion of the dog is very peculiar. Here he has alighted on one foot, changed it to the next fore foot, and then he leaves the ground with the fore feet. In the next you find him entirely in the air, his feet all doubled up under him; he then comes down on his hind feet. Then he brings the next hind foot down, and leaves the ground again, so that he is in the air twice during a single stride—once with his body curled up, and the other when perfectly extended. I do not think that fact has ever been commented on by a writer on natural history. Here is a photograph of two dogs running a race; they were photographed together; one was a faster dog than the other, and you see how he gradually overtakes his competitor.

Next we have the ox; here are two oxen from the column of Theodosius, and they are both correct. There is one peculiar feature in the walk, of which I should like to tell you. Artists ought really to be close observers of animal movements, but it is rare to find an artist who can tell you the manner in which an animal will walk. There are two artists here, and they have not been able to tell me. There is one invariable rule with regard to the walk, so far as my observation has extended, and that is that the succession of footfallings are with any animal precisely the same; whether a dog, a horse, a monkey, or the giraffe, they are all the same. Assuming you commence your observation with the left hind foot, the next foot to touch the ground would be the left fore foot, followed by the right hind foot, and that again by the right fore foot. That order, so far as I am aware, is universal. I would not be positive so far as all animals are concerned, the hippopotamus for instance, but, so far as I have had an opportunity of judging—certainly, so far as I have photographed—it is so. You may think it a very easy thing to watch an animal, and see how it walks, but it is very difficult. There is as much difficulty in watching the massive movements of an elephant as the more light and rapid movements of the horse. I am not quite satisfied in my own mind yet whether an elephant is upon diago nals during a walk or not; I know he is on laterals, but during half an hour's observation I could not really positively say whether he was supported by the diagonals alone or not. With the hippopotamus I know that to be the case, but I almost question really whether an elephant in walking is supported entirely by diagonals. Here again we have a picture of an ox, by Rosa Bonheur. This is a very celebrated picture in the Luxembourg. Those two oxen are represented in a manner that no oxen would ever think of getting into. You might get a cord, and pull their feet into that position, but it would be strongly against their will. There is another one here by the same artist which is more nearly correct, but not quite.

Next we have a series of photographs of an ox walking, and the same principle holds good. The succession is the same. The trot of the ox is pretty much the same as that of the horse. The next is a wild bull; he was really wild enough for a Spanish bull fight; we had to build a long lane in order to get him to run straight, and we had three or four men ready to catch him in case he should make for the cameras. The bull gallops pretty much like a horse. Next we have a set of photographs of the pig. I thought I would attempt the pig, not that I hoped to gather much information from his movements. The principal event of our experiment was the difficulty we had in inducing him to go forward; of course we followed the old principle of drawing him backwards.

Next I have a set of photographs of the deer. Some writers on animal movements have compared the gallop of a horse to that of the deer, but there is really a considerable difference. We see that the deer takes somewhat the conventional style of the horse in galloping. The gallop of the deer is hardly a gallop, it is almost a series of bounds. The deer does leave the ground with the hind foot, and lands on the fore foot, which the horse does not.

Now, we come to the movements of mankind. This man is walking pretty fast, a seven foot stride. With regard to the walker, we all know that he lands on the heel; but in taking a run, if you ask any athlete in what manner he runs, I think he would tell you that he would not alight on the heel, that he would alight on the ball of the foot. They are generally very confident that in running they never come down on the heel. That is the opinion of the runner himself, I think, in nine times out of ten, and it was with very great difficulty, after this man had run, and had seen these pictures, that he could convince himself of the fact that in running he always came down in this manner. It is the same with the man as with all other animals, as far as I am aware, they always come down on the heel. Here is a photograph of a long jump of 16 feet, without any particular attempt to jump high. Here is one of a man clearing a hurdle four feet high. You would think that clearing a hurdle of that height, if it were possible for him to come down on his toes, and so break the force of the concussion by springing, that he would do so. But you see here where that man's toes are. He comes right down on the heel, and that is the only way in which he could come down. The man finds his springs in his knees when jumping; the horse finds them in his pasterns. [The various movements in running and jumping were then exhibited in the zoöpraxiscope.]

In the next photograph we see men performing athletic feats, particularly feats of strength. They are on too small a scale to show the play of the muscles. But I have a series on a larger scale of men wrestling, in which the action of the muscles is very well shown. This series of exposures was made in a slightly different way. Of course, the men in wrestling were pretty much in a small circle, and, therefore, different means had to be adopted for regulating the successive exposures. The cameras were all concentrated on one point, and an apparatus was constructed to cause them to receive the exposure at stated intervals of time, instead of distance. Here are photographs of a twisting somersault; next a flip-flap, the movement which is made preparatory to making a back somersault, and here is a back somersault. I will show these in the zoöpraxiscope. Of course, the construction of this instrument requires the movements to be effected more rapidly than a man in performing the same result would naturally do. The horse on which he is standing, instead of making two strides, would probably make three or four before he turned the second somersault. But in order to show that, it would require a disc of 10 feet circumference.

At the request of my friend, Professor Marey, of Paris, I gave some attention to illustrating the position of birds, but I cannot say I was very successful. The movement of the wing are so extremely rapid, and it is a small object any way, so that the information we have obtained from the movements of birds I cannot congratulate myself upon; however, here are a few of the results. There are only two nations, that I am aware of, in which the artists have ever thought of illustrating birds with their wings downwards; of course, artists must know that birds' wings go down, but I suppose they imagine it is inartistic to draw them in that way. The ancient Egyptians would frequently illustrate their birds with the wings downwards, and the other nation is the modern Japanese. You frequently find, in Japanese books, birds illustrated with their wings downwards. I show you these few photographs of birds, but perhaps, they are of more value for art than for science.

I have now some illustrations of groups of horses galloping. These really are more difficult to make, because they were made in the open fields without any of the apparatus which I have described. There are also a few picture subjects, showing groups of horses, which are, perhaps, more interesting to the artist. Lastly, I will show with the zoöpraxiscope a picture, which we may call Rotten-row [This was a picture of a number of horses, dogs, and men, showing the various motions of running and trotting].

In conclusion, I have only to say that, if there is anyone who desires to investigate the subject further, it will afford me great pleasure to give every information in my power.

The CHAIRMAN said he was quite sure it would be unnecessary for him to say that all members present must feel as he did himself, greatly indebted for the kindness with which these processes had been placed before them; and he might also say that very many would feel great admiration for the perseverance and skill with which this matter had been developed. There was no doubt at all but that there were very few who were even aware of the movements of their own limbs. He confessed it was a matter he had thought a good deal about at times, but had never been able to realise to his own satisfaction how it was he was able to walk. He was, himself, some years ago, made aware that the amble was particularly well developed, not only amongst mules in Spain, but was a very favourite gait amongst the Dutch of South Africa. Every man there taught his horse to amble. He had a horse himself which was a very good ambler indeed. He had studied the movements, he might say, for years, but he could not make head or tail out of them. He had watched the horse again and again in a most close way—as an anatomist, as an observer, and as, he should imagine, an artist would—but he did not know how it was that the amble was got out. He referred to this in order to bring before the meeting how valuable, on scientific grounds, was the apparatus they had had displayed. If that apparatus were made use of to study the movements of a horse or any other animal, it was possible, by careful observation, to ascertain exactly what the animal did, and he could prove that in an admirable way. In the amble there was a peculiar sense to the rider; it was a movement, as they had heard, in which the back of the horse moved very little indeed out of one plane, but the rider was conscious of a singularly slight oscillation from side to side in the same plane; it was a very easy gait. You simply felt a slight jerk sideways, and when you once got accustomed to it, you could never forget it. Now, he had noticed on the screen that the man on the ambling horse had distinctly that sideways motion, which he had himself felt in riding. He mentioned that to show how exact this apparatus was. He was sure they would all join in a hearty vote of thanks to Mr. Muybridge, and he was sure they would all be willing to express their admiration, not only for the skill and scientific accuracy with which this had been developed, but for the interesting way in which it had been brought forward.

The vote of thanks having been passed,

Mr. MUYBRIDGE, in returning thanks, said he might illustrate what Dr. Mann had said with regard to observing the peculiarities of the amble. An able article recently appeared in the *Builder*, upon the physiognomy of motion, stating that every man had a motion peculiarly his own, as much so as his features; so that although a man wore garments with which they were unacquainted, his friends would recognise him at a distance by his gait. Now, he could illustrate that with regard to the gait of horses. In the first series he made, showing a horse in the act of galloping, he showed it in triumph in the zoöpraxiscope, to the owner of the horse, Mr. Stanford, and said he supposed he would recognise his horse, Florence Anderson. "Well," said Mr. Stanford, "You have got a galloping horse there, but it is not Florence Anderson." He replied that it was, that the trainer had sent it out to him, and that was a picture of it. Mr. Stanford said he was quite satisfied that it was not Florence Anderson, and on the man being sent for, it turned out to be another horse. That showed that not merely a galloping horse could be illustrated in this way, but that even a horse's peculiar gait could be so rendered by the instrument that it should be recognised by anyone familiar with the animal. He could not, perhaps, distinguish the gait of one from the other, but the owner could at once. Another thing he should like to remark was that he did not by any means exhibit these as perfect pictures, but simply as experiments, and next year he should hope to be able to show experiments more worthy of approval.

Miscellaneous.

DOMESTIC ECONOMY CONGRESS.

The Committee of the Congress have sent the following report, with a request for its publication in the *Journal*:—

At the conclusion of the Domestic Economy Congress, held in June last, 1881, the Executive Committee decided not to dissolve until the promised revision of the Educational Code had been issued.

After the "Proposals" appeared, a deputation from the Commitee was received by Earl Spencer and Mr. Mundella, on the subjects included under the term "Domestic Economy."

The Committee urged the abolition of the term, and the substitution of specific names understanded of the people. In particular, they urged that distinct encouragement should be given to cookery.

The reply was very favourable, and though the New Code, when it appeared, did not give all that had been asked, it was felt that as much had been done as could be expected, considering the cautious character of English statesmanship in matters of education.

The Committee have, therefore, brought their work to a close, and at their last meeting, held June 8th, 1882, passed the following resolutions:—"That the Committee desire to record their sense of the loss which this movement has sustained by the death of Sir Henry Cole, and to offer to Lady Cole and family the expression of their sincere condolence." "That her Royal Highness Princess Christian be informed that the New Code having adopted the main principles so long advocated by the various Domestic Economy Congresses, the Committee have dissolved, and tender to her Royal Highness their best thanks for her kind patronage and support."

The two following letters are the final correspondence with the Education Department:—

19, John-street, Adelphi, W.C.
27th March, 1882.

Sir,—I am instructed by the Executive Committee of the Domestic Economy Congress, to inform you that having carefully studied the New Code of Regulations passed by Minute of 6th March, 1882, by the Lords of the Committee of Privy Council on Education, the Executive Committee desire to express to the Lord-President and the Vice-President of the Committee, their cordial thanks for the issue of that new Code, which appears to them to mark an important step in the progress of National Education, and its probable influence on National Home Life and its Duties. The Executive Committee are prepared to continue exertions in bringing before the public the help which the Code so far gives. But on the present occasion the Executive Committee abstain from further observations.

I have the honour to be, Sir,
Your obedient servant,
(Signed) Lætitia M. Cole,
Hon. Sec.

To Sir Francis Sandford, K.C.B.,
The Secretary,
Education Department.

New Code (Domestic Economy).

Education Department, 26th April, 1882.

Madam,—Adverting to your letter of the 27th ult., I am directed to state that my Lords are very glad to learn that your Committee entertain a favourable opinion of the New Code, and its probable influence on Home Life.

I have the honour to be, Madam,
Your obedient servant,
(Signed) F. R. Sandford.

Miss L. M. Cole,
19, John-street, Adelphi, W.C.

MINERAL INDUSTRY IN RUSSIA.

The following particulars, in which the mineral production of 1879 is compared with that of the five previous years, are based upon figures collected by the sub-director of mines in Russia, and published in the *St. Petersburg Herald.*

Compared with former years, mining enterprise made a certain amount of progress in Russia during 1879; but, notwithstanding the activity generally manifested, the mines are still far from meeting the consumption, each year increasing, of ore, metals, and articles made of metal.

The production of gold was, in—

1874	2,028	puds*	4	pounds.
1875	1,995	,,	29	,,
1876	2,054	,,	4	,,
1877	2,502	,,	7	,,
1878	2,572	,,	4	,,
Average	2,230	,,	17	,,

In 1879, the production was 2,631 puds 30 pounds, that is to say, an increase of 401 puds over the mean annual extraction of the quinquennial period from 1874 to 1878, and of 59 puds over that of the preceding year.

In Eastern Siberia, the production of gold diminished, on account of the dearness of provisions, the advance of wages, the cost of transport, the sanding up of several districts, and the drought in Nertschinsk and Tschitinsk, on the Eastern slope of the Jablonoi mountains. In Western Siberia, the production slightly increased, and in the Oural it increased considerably, on account of the arrival of a large number of good workmen at the mines of Miassk, and the discovery of several deposits of rich auriferous sand in the *datsche* of Zialkovsko-Demarinsk, and in the new Orenburg line, in the circle of Orsk.

At the end of 1879, the number of gold mines belonging to private individuals rose to 1,522 in Eastern Siberia, to 291 in Western Siberia, and to 1,233 in the Oural.

The production of platinum was, in—

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* The *pud* contains 40 Russian and 36 avoirdupois pounds. To reduce *puds* to tons, multiply by ·0160714, or divide by 62·2.

1874	122 puds	39 pounds.
1875	94 ,,	7 ,,
1876	96 ,,	8 ,,
1877	105 ,,	16 ,,
1878	126 ,,	13 ,,
Average	109 ,,	1 ,,

In 1879, the production was 138 puds 10 pounds, showing an increase of 29 puds 9 pounds, over the five-yearly average, and of nearly 12 puds over the quantity of the preceding year. This metal is extracted in the Governments of Perm and Orenburg.

The extraction of silver was, in—

1874	720 puds	14 pounds.
1875	601 ,,	4 ,,
1876	683 ,,	18 ,,
1877	681 ,,	17 ,,
1878	699 ,,	7 ,,
Average	677 ,,	4 ,,

In 1879, the production was 697 puds 13 pounds, showing an increase of more than 20 puds over the quinquennial period, but a diminution of nearly two puds from the production of 1878. This matal is chiefly obtained from the territory of the Tomsk, and the basins of the Baikal and Terek.

The production of lead reached in—

1874	18,150 puds.
1875	66,060 ,,
1876	71,278 ,,
1877	73,517 ,,
1878	85,281 ,,
Average	62,857 ,,

The production in 1879 was 82,842 puds, showing an increase of 19,985 puds over the five-yearly average.

The extraction of copper was, in—

1874	199,527 puds.
1875	222,769 ,,
1876	236,452 ,,
1877	213,931 ,,
1888	214,884 ,,
Average	217,512 ,,

The figures for 1879 were 190,680 puds, which shows a falling off of 26,832 puds. This is chiefly due to a temporary slackness at the Wysk establishments in the Oural.

The production of zinc rose in—

1874	to	251,811 puds.
1875	,,	243,280 ,,
1876	,,	282,198 ,,
1877	,,	282,724 ,,
1878	,,	283,398 ,,
Average		268,682

In 1879, the quantity was 263,588 puds, showing a diminution, from the average, of 5,094 puds, due to the fewness of orders.

The production of tin did not exceed 125 puds, or 31 puds less than the raise of the preceding year.

The production of pig-iron was, in—

1874	23,212,772 puds.
1875	26,061,323 ,,
1876	26,956,350 ,,
1877	24,403,319 ,,
1878	25,472,540 ,,
Average	25,221,360

and in 1879, 26,412,806.

The quantity of steel turned out rose in—

1874	to	526,778 puds.
1875	,,	789,253 ,,
1876	,,	1,093,719 ,,
1877	,,	2,702,863 ,,
1878	,,	5,801,754 ,,
Average		2,182,873

and in 1879, to 12,929,170.

The production of pig-iron was, therefore, increased by 940,266 puds, with respect to the previous year's returns, and by 1,191,446 puds, as compared with the average of the five-yearly period.

In wrought iron there was an increase of 432,125 puds over the figure of the previous year, and a diminution of 361,423 puds from the average of the years from 1874 to 1878. This diminution is the natural consequence of the rapidly increasing production of steel, which has made extraordinary progress, especially at St. Petersburg, in Poland, in the Oural, and in the Brjansk establishments.

The year 1879 shows, for steel, an increase of 7,127,416 puds over the figures of the preceding year, and of 10,747,297 puds over the five-yearly average. This increase in the steel manufacture is almost entirely due to the numerous orders for the State railways, and to the premiums granted by the Government.

The manufacture of wrought iron and steel barely amounts to half the demand. To form a just idea of the measure in which the production is inferior to the consumption, it is sufficient to call to mind the quantity of rails necessary for the construction and repairs of the iron ways of the Empire. In 1879, there were 21,841 versts* of railway opened, without counting the sidings. Besides, the Russian railway system receives marked additions every year; and the double line of way is coming generally into use. Besides rails, large quantities of iron and steel are absorbed in the construction of bridges, the fixing of the rails, the rolling stock, and in buildings.

The extraction of coal, lignite and anthracite rose in—

1874	to	78,813,137 puds.
1875	,,	104,348,067 ,,
1876	,,	111,302,028 ,,
1877	,,	110,120,054 ,,
1878	,,	154,024,302 ,,
Average		111,721,517

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* A verst = 500 sagines = 0·66 mile; ∴ 21,841 versts = 14,473 miles.

The output of 1879 amounted to 178,238,013 puds, showing an increase of 66,516,496 puds over the five-yearly average, and of 24,213,711 puds over the amount raised during the preceding year. This result is chiefly due to the extension of the works in the basins of the Donetz, of Poland and of Moscow. In Poland, the quantity raised has almost quadrupled in ten years, notwithstanding which fact, it is not sufficient to meet local requirements, and the deficiency has to be supplied by the Silesian collieries. A great increase in the extraction of coal is anticipated on the completion of the projected railway between Dombrova and Ivangorod, passing through the eastern coal basin of Poland.

The production of naphtha rose in:—

1874	to	5,208,710	puds
1875	„	8,174,440	„
1876	„	10,937,100	„
1877	„	12,511,133	„
1878	„	15,324,167	„
Average		10,431,110	„

In 1879, the production was 21,475,969 puds, that is to say, an increase of 11,044,859 puds over the five-yearly average, and of 6,151,802 puds over the production of the previous year. This increase is accounted for by the gradual substitution of this substance for American kerosine, and the deterioration of the stocks of naphtha.

No graphite or nickel were extracted; but the production of arsenate of cobalt rose in 1879 to 909 puds. The absence of demand is a great obstacle to the development of the production of nickel. In the nickel factory of Revdinsk, the only one established in Russia, there were produced, in 1879, 1,200 puds of nickel powder and raw nickel, with a content of metal varying from 21 to 98·5 per cent. The greater portion of this production finds its way to foreign countries. The price of pure nickel is 110 roubles[*] per pud; and at St. Petersburg it is sold by merchants at the rate of 125 to 165 roubles per pud. The production of chromate of iron has, in later years, reached an average of 300,000 puds.

There are no regular statistics as to the production of minerals, except in the case of rock salt. The quantity raised of this substance reached in—

1874	46,947,518	puds.
1875	37,991,399	„
1876	43,806,762	„
1877	28,952,185	„
1878	47,678,528	„
Average	41,075,278	„

In 1879, the production was 49,729,889 puds, showing an increase of 8,654,611 puds over the five-yearly average, and of 2,051,361 puds over the production of the previous year. The cause of this increase may be traced to the extension given to the salt-works of the Astrakan lakes, and to more active working of other deposits.

The produce of Glauber salt was 83,001 puds in 1879, or 8,637 puds less than during the previous year.

The value of money coined in Russia was in—

1874	30,620,322	roubles.
1875	27,973,831	„
1876	65,368,555	„
1877	58,545,133	„
1878	48,740,853	„
Average	46,249,738	„

And in 1879, 42,040,825 roubles. The diminution during the later years is explained by the political events which, from 1876 to 1878, exerted great influence on the coinage.

There is no precise information as to the extraction of precious stones, now very limited. The data as to the production of peat are also very incomplete. The total number of workmen employed in the mines, works, &c., was in—

1874	244,369
1875	267,990
1876	286,122
1877	256,919
1878	282,959
Average	267,671

And in 1879, 292,046, that is to say, 24,375 workmen more than during the quinquennial period under consideration, and 9,087 more than in 1878. In 1879, 189 men were killed and 422 wounded in consequence of accidents, the total number of victims being 186 more than in 1878, and 174 more than the five-yearly average. In 1879, the number of works in activity in Russia, without reckoning Poland, Siberia, Finland, or the Caucasus, was 931; and the total value of the production amounted to 87,391,212 roubles, or £13,982,553.

In 1880-1, the exports of metals amounted to 15,048, 496 roubles (£2,407,755) showing an increase of 6,156,592 roubles (£985,054) over 1879-80, and of 12,402,366 roubles (£1,984,378) over 1878-9. On the other hand, the imports of metals (2,836,998 roubles = £453,919) in 1880-1 shows a diminution of 1,145,342 roubles (£183,254) with respect to 1879-80, and of 3,070,323 roubles (£491,251) with respect to 1878-9. On the 13th August, 1881, the receipts for Customs dues were 37,262,891 roubles (£5,962,062), showing a diminution of 11,448,508 roubles (£1,831,761), compared with 1879.

WASTE LANDS IN BRITISH BURMA.

The following particulars respecting waste lands available for planters in the Tavoy District of British Burma, have been communicated by the Secretary of State for India in Council:—

Waste lands, covered at present with forest bamboos, or grass, are available for plantations of coffee, tea, cinchona, or spices, at altitudes varying from 100 feet to 6,800 feet above the sea, in the Tavoy district. This region is between the 13th and 14th parallels of north latitude, and the rainfall ranges from 190 to 220 inches a year. The lands are mostly within 30 to 50 miles of the steamer station of Thayetchoung on the Tavoy river. Mail steamers ply between Thayetchoung and Moulmein, or Rangoon, once a week, inwards and outwards, beginning from the 1st of January, 1882. Grants of land, in lots ranging from 100 to 1,200 acres, can be had, for planting tea, coffee, cinchona, or spices, on application to the Deputy Commissioner of Tavoy. Such grants will be made in accordance with the "Burma Land and Revenue Act, 1876," and with the rules sanctioned thereunder by the Governor-General of India in Council. Copies of the Act and rules can be obtained by intending planters, on application to the Deputy Commissioner of Tavoy, the Commissioner of Tenasserim at Moulmein, or the Secretariat, Rangoon. In addition to the concessions and conditions laid down in the Act and rules, the following special concessions will be made to persons taking up land for plantations of coffee, tea, cinchona, or spices in Tavoy, namely:—(1.) A grantee will become proprietor of his grant as soon as he brings under cultivation one-third of the area thereof; (2.) A grantee will not be liable to pay any land revenue, or any price for the land of his grant until the end of the tenth year after he enters on possession, provided that he takes *bonâ-fide* steps to cultivate a reasonable proportion of the grant with coffee, tea, cinchona, or spices. In the event of any grantee desiring a more precise definition of a "reasonable proportion" the Chief Commissioner may decide beforehand in each case what proportion of the grant ought to be thus cultivated in each year; (3.) After the end of the tenth year, the grantee will be liable to pay land revenue, at the rate of Rs. 1. 4 per acre, and cesses at the rate of two annas per acre on one third of his grant, up to the year 1900, A.D.; after the expiration of such year, he will be liable to pay for one third of his grant the same revenue rate as is paid for garden lands in the nearest revenue circle where a garden rate obtains; (4.) A grantee will not be called upon to pay anything for timber, bamboos, or grass which he may cut upon his grant, provided he takes *bonâ-fide* steps, as aforesaid, to cultivate coffee, tea, cinchona, or spices.

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[*] The rouble is equal to about 3s. 3d.; consequently the cost price of nickel is about 10s. per lb., and its selling price from 11s. to 15s.

The only payment which a grantee will have to make, on receiving his grant, will be eight annas an acre for the costs of survey and demarcation. In consideration of such payment, the Deputy Commissioner will cause survey to be made of the grant, will furnish the grantee with a copy of such survey, and will cause boundary marks to be erected at suitable points in the outer boundary of the grant.

The Government is now spending much larger sums than heretofore on roads in the Tavoy district. If planters settle in the district, further funds will be allotted for roads from their neighbourhood to the steamer station at either Tavoy or Thayetchoung. In order to encourage pioneers in the coffee and cinchona enterprise in Tavoy, the Government will pay to the first four grantees who begin *bonâ-fide* planting operations Rs. 15 per head for every Indian or Chinese coolie, male or female, over 16 years of age, who may be settled and housed on their plantations before the 1st March, 1885. All minerals and metals under and within the lands granted under these rules are reserved by Government, together with the right to enter upon and resume such portions of land as may be necessary for examining or working mines, upon payment of just compensation to the grantee for loss of, or injury done to, the surface.

GREENWICH OBSERVATORY.

The annual visitation of the Royal Observatory was held on Saturday, 3rd inst., when the first report of Mr. W. H. M. Christie, F.R.S., as Astronomer Royal, was presented to the Board of Visitors. The report contained the usual account of the present state of the Observatory, divided under nine heads.

The new library, a building 55 feet long and 18 feet broad, was erected at the end of last year, but it is only now ready for the reception of books. It is proposed to transfer to the new building, which is close to the Magnetic Observatory, the sections magnetism and meteorology, as well as books in other sections, and manuscripts from the record room, to which reference is seldom made. Sufficient space will thus be gained for the proper arrangement of books in the two rooms forming the old library, which is more conveniently placed for the use of the Astronomical Department.

A subsidence of the ground having taken place last summer in the garden south of the transit-circle, close to one of the supposed sites of the well dug by Flamsteed, for observation of stars in daytime, an excavation was made, but no trace of the well could be discovered. Of the transit of Venus instruments, two transits, three altazimuths, five 6-inch equatoreals, two photoheliograph mountings, nine clocks, and one transit of Venus model have been sent to Mr. Stone. at Oxford for use in the forthcoming transit of Venus, and three transits, an altazimuth, a photoheliograph, and two clocks are at the Cape of Good Hope, where they will be available for the transit of Venus. A photoheliograph is mounted at the Royal Observatory for daily use, another is at South Kensington, and the telescopic part of another (without mounting) is in India. There are also three transit of Venus models. The "Naylor" equatoreal, which is in use here for observations of comets and other occasional phenomena, has been moved to a more convenient position in the lower part of the south ground, at a much greater distance from the dip instrument. This equatoreal will also be available for the coming transit of Venus. Two four-inch telescopes on tripod stands have been lent to Captain Wharton, R.N., for observation of the transit of Venus during his cruise in the Straits of Magellan. The portable transit with axis view has been lent to Captain Mackinlay, R.A., for practice at Woolwich, in preparation for the transit of Venus.

Astronomical Observations.—No alteration has been made in the subjects of observations, which continue to be, as in past years, the sun, moon, planets, and fundamental stars, with other stars from a working catalogue of about 2,500 stars. Special attention is given to the observation of long groups of clock-stars and of stars by reflection. About 1,000 stars were observed in 1881.

Spectroscopic and Photographic Observations.—During the twelve months ending 1882, May 20, the sun's chromosphere has been examined with the half-prism spectroscope on 36 days, and on every occasion prominences were seen. One day a detailed examination of the whole spectrum of the chromosphere was made at 24 points of the sun's limb. Several prominences have shown great changes in the course of two or three minutes, and large displacements or contortions of the bright lines, indicating very rapid motions of approach or recession, have been noted. In particular, a prominence examined on 1882, May 12, was observed to rise through a space of about 30'' in less than two minutes, being at the rate of about 110 miles a second, whilst the C line showed a displacement towards the red gradually increasing from 1¼ to 11·4 tenth-metres, corresponding to a motion of recession increasing in two minutes from 36 to 330 miles a second. Thirteen sun spots have been examined on 20 days with reference to the broadening of the lines in their spectra. The strong black lines or bands in the part of the spectrum between *b* and F, first noticed in the spectrum of a spot on 1880, November 27, have been gradually observed to be present in the spectra of spot during the last twelve months, besides several fine lines in the same region of the spectrum to which there is nothing corresponding in the solar spectrum.

In the year ending 1882, May 20, photographs of the sun have been taken on 200 days, and of these 352 have been selected for preservation. Since the end of last August photographs have been taken on Sundays as well as on week days. There were only two days out of 200 on which the sun's disk was observed to be free from spots and faculæ, the mean of the daily areas for each in 1881 being nearly double of the corresponding quantities for 1880, and the increase is still continuing, though with well-marked fluctuations. A very remarkable outbreak of spots occurred in April last.

Magnetical Observations.—On four days during the year, viz., September 12 and 13, and April 16 and 19, magnetic storms have occurred. Those of April were of more marked character than any that have taken place since the great storms of 1872, and it is a significant fact that exceptionally large spots made their appearance on the sun shortly before, viz., on April 11 and 17. Smaller magnetic movements are now also much more frequent, the traces exhibiting a marked contrast to their general appearance some two or three years ago.

Meteorological Observations.—The mean temperature of the year 1881 was 48°·7, being 0°·6 lower than the average of the preceding 40 years. The highest air temperature was 97°·1 on July 16, and the lowest 12°·7 on January 17. The mean temperature was below the average, 6°·7 in January, and 4°·8 in October, and above the average, 5°·9 in November. In other months the temperature in general differed little from the average. On four days in July the temperature rose above 90°.

The mean daily motion of the air in 1881 was 291 miles, being 12 miles greater than the average. In January and September, the mean daily motion was 70 miles and 72 miles below the average, respectively. The greatest daily motion was 999 miles, on October 14, the day of the great storm; and the least, 59 miles on May 25. A velocity of 61 miles an hour was recorded on October 14, and one of 58 miles an hour on April 29, these being both greater than any recorded in previous years. The greatest pressure was 53 lbs. on the square foot on October 14; pressures of 46, 47, 47, and 48 lbs. were also registered during the same gale. On April 29, a pressure of 49½ lbs. was recorded at a time when the hourly velocity was 50 miles; the pressures corresponding to the maximum velocity of 58 miles an hour were not registered, the cord of the pressure pencil having slipped off the pulley.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1881, was 1,301, which is more than 100 hours above the average of the four preceding years.

Chronometers and Time Signals.—The number of chronometers now being tested at the Observatory is 214, 168 of which (120 box-chronometers, 23 pocket-chronometers, and 25 deck-watches) belong to the Government, and are being rated after repair previous to being issued to the Navy. The remaining 46 are for the annual competitive trial, and of these 18 are fitted with Airy's supplementary compensation. In additions to the above, six chronometers have been placed on trial for the Mauritius Observatory, and five chronometers have been tested for the Japanese Government.

There has been only one case of accidental failure in the automatic drop of the Greenwich time-ball. On four days the ball was not raised on account of the violence of the wind. The Deal ball has been dropped automatically at 1ʰ on every day throughout the year, with the exception of fifteen days, on which there was either failure in the telegraphic connexion or interruption from telegraph signals continuing up to 1ʰ, and of one day when the current was too weak to release the trigger without the attendant's assistance. On three days high wind made it imprudent to raise the ball. The Westminster clock has continued to perform well, its errors having been under 1ˢ on 40 per cent. of the days of observation, between 1ˢ and

2^s on 44 per cent., between 2^s and 3^s on 14 per cent., and between 3^s and 4^s on 2 per cent. Time-signals, originating in the Observatory, are distributed at 10^h a.m., and 1^h p.m. to all parts of the country by the Post-office telegraphs.

AMERICAN TIMBER SUPPLY.

There are at present, writes the *Architect*, about about 15,000 square miles of forest in Maine. But notwithstanding the existence of so vast an area of timber land, it appears to be generally admitted that during the last fifty years the forest wealth of this State has been wasted in a deplorable manner. The valuable and gigantic white pine has become a rare tree, and has disappeared almost entirely from the banks and vicinity of the large rivers of Maine, and of the St. John River, as well as of most lakes in this State, where, during the first quarter of the present century, numberless specimens of these magnificent trees might be seen. They have, since that period, been cut down with great wastefulness by lumber men, who, as a rule, have merely used a section of their trunks for boards, and have thrown away into river the waste slabs, &c., which might have served for making doors and similar articles. In some parts of Maine, specimens of the white pine may, it is said, still be met with, measuring 6 feet in diameter at the base, and 240 feet in height; trees measuring 4 feet in diameter are said to be, comparatively speaking, quite common. Previous to the American Revolution, every white pine in this State which measured at least 2 feet in diameter at its base (excepting in a few districts) was the property of the British Crown, and was used for making masts and spars for the Royal Navy. The yellow pine, likewise a magnificent tree which grows in Maine, has almost equal dimensions with the former, but its wood is harder and thicker grained, and is, therefore, generally employed for making floorings and ships' planks. The Norway pine is smaller in size, but with more spreading boughs; the wood is of closer texture and the bark rougher. The pitch pine is found in some parts of Maine, and is well adapted as fuel where very hot fires are needed. Besides these species of pine, the more important kinds of trees, to be met with in the forest of Maine, are, hemlock, elm, maple, beech, and button-wood; next following in size are—oak, birch, basswood, and ash; whilst the most prominent amongst the smaller trees, are larch, cedar, fir, spruce, poplar, and black-cherry. The principal forms in which Maine lumber is sold at present are, beams, flooring-timber, and scantlings. First-class pine-boards, used in the interior finishing of dwelling-houses, and for similar purposes, are, however, no longer obtainable in this State, nor in any part of New England or New Brunswick, owing to the disappearance of the white pine; and this class of wood has now to be imported from Michigan. The coarser sapling timber pine has taken the place of the superior board pine; and the most valuable timber obtained at present on the banks of the River Penobscot, the Kennebec, and other large waters, are spruce and hemlock. Along the River St. Croix timber of all kinds is said to be becoming scarce, and many saw-mills which used to be at work 25 years ago, have, during the past years, been gradually discontinued. On the banks of the Machias, Narraguagus, and Union Rivers, in the north-eastern portion of Maine, large tracts of forest may yet be found; but even here many saw mills now disused show that the most profitable period of the lumber trade of those districts has passed away. It is only in some of the southern parts of this State, more especially in the districts traversed by the Rivers Saco and Andrascoggin, that greater care appears to have been bestowed upon the preservation of the most valuable kind of trees, and it is stated that here the valuable species of native pine above mentioned may now be found in greater abundance than seventy-five years ago. The chief lumber market of Maine continues to be Bangor, on the River Penobscot—a town numbering at present about 17,000 inhabitants. Though the quantity of wood bought and sold here in the course of one year is probably as great at present as it used to be ten years ago—when the average annual shipments are stated to have reached 247,000,000 feet—the quality of the lumber now brought to the Bangor market has changed, owing to the above-described causes, and most superior kinds have disappeared. The lumber and wood trade of Portland continues likewise to maintain its importance; it is, however, not practicable to ascertain the extent or precise nature of the present trade in this article at this port, owing to the disinclination of the merchants to supply any information on this or other subjects connected with the trade of Portland.

FRUIT-GROWING IN JAMAICA.

Just as the ravages of *Hemileia vastatrix* have induced the planters of Ceylon to turn their attention, with great advantage to themselves, to the culture of chinchona, tea, cocoa, and other produce, instead of pinning their faith to coffee alone, so the sugar growers of Jamaica have learnt by adversity, the impolicy of devoting their whole capital and energies to the production of the single article, sugar. Encouraged by the success of the experiments which have been made by the energetic director of the Botanical Gardens at Kingston, they have turned their attention, with great success, to the introduction of chinchona, while cocoa, vanilla, and other indigenous plants, which have not hitherto been thought of such importance as to demand serious efforts to secure an extensive produce and sale, are being taken in hand. In fruits of various kinds perhaps the greatest success has been attained so far, and instead of merely collecting enough to supply local wants, and remaining content with an occasional shipment to New Orleans of fruit which, possibly, owing to bad packing, went bad before it reached its destination, Jamaica planters are developing a remunerative trade in oranges, bananas, pine-apples, limes, shaddocks, mangoes, and other fruits. Even grapes are being grown for export. The United States are, at present, the chief market for this produce, but England receives no small share of the yield, and still larger quantities of fruit, in even greater variety, will no doubt be shipped to Europe, as experience shows that better means of packing can be employed to avoid the deteriorating effects of a long voyage. The export of oranges to the United States, from Jamaica, has increased by 50 per cent. in the last six years; of bananas, it is expected that the export this year will reach 2,000,000 bunches, or 20 times as much as in 1876. When it is remembered that each "bunch" contains about 250 pods, the extent of the trade may be realised. Fifteen million cocoanuts, or double the quantity exported last year, will, it is anticipated, be sent out of the island before the end of the present season. Oranges are one of the principal items in the fruit trade, and as the Jamaica variety has a peculiar property of keeping good for a longer period even when fully ripe, than the European variety, the advantage which the island has in the growth of this fruit is very great. These few instances will show the advance that is being made by Jamaica in this direction, and the possibilities that lie before planters in the future. To small capitalists of a horticultural rather than an agricultural taste Jamaica offers, in her delicious climate, her fertile soil, and the abundance and variety of her produce, exceptional advantages. Small areas of land can be had on very reasonable terms, and few colonies present better opportunities to gentlemen of small means who would turn to profitable account that love of "gardening" which is innate in most Englishmen. Fruit culture in Jamaica demands little of the hard labour of wheat farming, while it yields results perhaps even more profitable.—*Colonies and India.*

TASAR SERICULTURE.

The following report from Major Coussmaker to the Secretary to the Indian Government, General Department, has been communicated to the Society of Arts, for publication:—

Poona, 3rd February, 1882.

SIR,—I have the honour to submit, for the consideration of Government, my report upon the progress made in Tasar Sericulture during the past year, as far as the same came under my notice.

1. I cannot yet state that I have succeeded in gathering a full season's crop of cocoons of my own rearing. I certainly had better results last year than in previous years, but still there were many deaths among the silkworms for which I could not account to my entire satisfaction.

2. I believe that my cages are as perfect and simple as can be; my plantation has thriven well, and I never thoroughly exhausted my stock of food, though once or twice I fancied that the caterpillars had begun to spin their cocoons before they were quite full grown. I can only imagine that there was some climatic influence which I did not perceive, or against which I was unable to contend with perfect success; or, although the cages kept out rats, birds, lizards, wasps, and other enemies of the silkworms, there may have been some small spiders, mosquitoes, or other equally minute enemies which I did not perceive. As it was, I gathered 1,000 cocoons from 270 feet of hedge during the monsoon.

3. I was fortunately able to commence operations at the earliest and most favourable opportunity. My first batch of worms hatched out on 2nd May and the first cocoon was spun on the 6th June. The last batch of worms hatched in the middle of November, but they gradually dwindled away and came to nothing, the last worm dying on 8th December. A skilful sericulturist might evidently extend the rearing over eight months in the year.

4. The whole season's collection amounted to 60,000, double of what it was in 1880, and collected in the same way. The contribution of the Forest Department amount to 58,000, against 17,000 in 1880, all gathered in the northern division. I had all these cocoons cleaned of extraneous matter, and the result being 200 lbs. of clean cocoons for the two years, I sent it all to Mr. Thos. Wardle, of Leek. His report will be most valuable, for these are all of this Presidency's production, and the quantity will be sufficient for him to pronounce thereon a decided opinion.

5. In the districts I, myself, purchased from the villagers about 1,000, which is about what I have been able to do for the past two years in the Ahmednagar Collectorate. Previously I had found them almost entirely on the "Bher" or "Bhori" tree—*Zizyphus jujaba;* but last year they were found on the "Ain" or "Sâdra" — *Terminalia fomentosa,* and the "Karanda"—*Carissa carandas.* I was at work in the Akola Tâluka of Ahmednagar, in a part where the majority of the cultivators habitually manure their seed beds with fresh wood ashes, and where two-thirds of these two trees are pollarded annually or cut back very hard. This cultivation is most favourable to the Tasar worm, for the constant lopping of the trees, and burning of the branches and leaves, harass the squirrels, birds, lizards, and wasps, while the fresh shoots which spring from the mutilated trees afford the best food possible to the worms. During the short time that I was there, I got more perfect cocoons than I have collected elsewhere. I made it a rule to always have a few empty cocoons in my pockets, and when I went out, I used to show these to the little village-boys who were tending cattle, telling them to bring me as many as they could, and that I would pay them for so doing. The consequence was, that every day when I returned to my tent, I used to find three or four children sitting down, waiting for me. I never refused to take the smallest collection, giving

them one pie for every two cocoons produced, and they went away exulting in the possession of two or three copper coins. Pretty prompt payment is what is required in this matter, and if the *Wáni*, the village retail dealer, would but take the matter up, the Tasar silk industry would soon be firmly established. The *Wáni* buys these cocoons in the Central Provinces, why should he not take them here too? There is no need for him or anyone to kill the chrysalids inside; he has simply to hang the cocoons anywhere where the rats cannot get at them, and let the moths escape until he can send the cocoons to Poona, or wherever the market may be. Until village *Wánis* or other independent traders will take the purchasing of the cocoons from the villagers up as a regular business, I fear that we can only look upon the collection of the same as a spasmodic affair fostered by Government officials, and carried on by the lower classes for the sake of currying favour with them.

6. As regards the prospects of the Tasar silk industry, they are most promising, and every year shows an improvement. Mr. Thos. Wardle has lately drawn up a most complete and minutely detailed account of the "Wild Silks of India" in his "Hand-book of the Collection in the Indian Section of the South Kensington Museum." In this he mentions how desirable it is that a trade in Tasar cocoons should spring up, for the uses of this silk are rapidly increasing, and the demand is far in excess of the supply; one of the most important uses to which it has been applied is in the manufacture of seal cloth. This beautiful fabric consists of a Tasar silk plush woven into a cotton back, and was sold in 1880 at 58s. 6d. per yard. When I was in England in 1873, the highest price obtained for any fabric manufactured from Tasar was 3s. 6d. per yard. For the manufacture of this seal cloth, yarn spun from the waste and from damaged cocoons is used. In December, 1879, I gave over to Government nearly 50 lbs. of this yarn manufactured in Bombay by the Alliance Spinning and Weaving Company from cocoons collected in this Presidency. In describing the various purposes for which Tasar silk yarn can be used, Mr. Wardle states, in weaving it into silk carpets, he finds that for very many reasons it is superior to mulberry silk, being lustrous, strong, and peculiarly suitable for embroidery.

7. As usual, I have sent seed to Mr. Stormont, of the Government experimental farm, Bhádgaon, and to Mr. George Baird, at Udepur, for the Maháràna's plantation, and expect to hear some particulars from them soon.

8. I have now laid out one-sixth of an acre as a plantation on one uniform system, and as this seems to answer well, I take this opportunity of describing it for public information. "Lagerstrœmia Indica" *Gul Mendhi* or *daiyeti*, is the best shrub in Poona for the purpose, and I have now planted 906 feet of it in hedges, besides having struck enough cuttings to make nearly as much more. The land is laid out in ridges seven feet wide, with a gutter of one foot between. The shrubs are put into a trench of good soil, mixed with manure, in the middle of each ridge, at one foot apart. On each side of these, on the ridges, vegetables of all sorts are being cultivated where the ground is not occupied with the cages, care having been taken to lay out the grounds in the way most suitable for irrigation, and to ensure the most being made of it at all times. The cages are made of rectangular pieces of split bamboo screen work tarred—a very cheap, light material, and when thus protected, it is neither liable to be hurt by the weather, nor gnawed by rats. In constructing the cages I tie these screens together, making the sides 3 feet high, and the ends 6 feet wide. The cage can be put up the whole length of the hedge, and is divided into 12 feet partitions. From side to side, arched over the top of the hedge, are pieces of rattan fastened down at their extremities to the screens, and in the middle to a light ridge pole, which rests on triangular screens stretching across the cage at intervals. Over the hoops thus made, coarse open cotton is spread, thus nothing touches the shrubs, for they are uniformly cut to a height of four feet, and the worms have no inducement to leave their food. The screens under the triangles at the end, consist of three, the middle one of which is fixed, and the two smaller on either side are fitted with string hinges, thus allowing boys to go in, and clean up on both sides of the hedges without injuring the shrubs. The worms are, when hatching, put upon the plants near the door, and they eat away, steadily crawling on to the next when their own twig has been stript. As fast as this takes place the bare twigs are cut off and fresh spring forth. In a few weeks' time, the hedge is as thick a mass of verdure as it was when the caterpillars were put upon it, and this process goes on as long as the rearing of the worms is continued. As partition after partition gets stripped, it can be taken down and shifted on further down the hedge or to a new place. An occasional watering is necessary if the weather is not favourable, but, as a rule, very little irrigation is necessary; still, it is as well to have the power at hand if required.

9. I have now spent the Rs. 500 placed at my disposal by Government in March, 1880; indeed, I have spent Rs. 67-10-0 over and above that sum, and I hope that Government will now place another sum of Rs. 500 at my disposal, the account of which will be, as usual, submitted to the Accountant-General.

I have the honour to be, &c.,

G. COUSSMAKER, Major.

General Notes.

RAGGED INDUSTRIAL SCHOOL IN VIENNA.—In 1881, struck by the miserable destitution of the children of the lower classes in Vienna, an English lady determined to establish a ragged school, where these children might be fed, educated, and taught a craft, by which they could earn a livelihood. The report of the Royal Commission of Inquiry into the condition of the agricultural classes shows how hard life is in the Venetian provinces, and the destitution of the towns is hardly less than that of the country, as may be inferred from the fact that Venice is the only one of the large cities of Italy in which the pellagra is commonly known. It would be difficult to mention any town in which the destitute classes are more numerous, or more dependent upon the assistance of their wealthier neighbours, and the need of such an institution as the Ragged Home is sufficiently proved by the success which it has met. It was commenced in March, 1881, as a day school, with an attendance of twelve boys only, the Free Italian Churches giving a couple of rooms for the purpose, and a colporteur of the church acting as schoolmaster gratuitously. The boys were also taught shoemaking, carpentering, and the making of cardboard boxes. It was soon found that, by sending the boys back to their wretched homes every night, the advantages gained by day were lost, and it was decided to modify the system. A disused church, with some rooms adjoining it, sufficient to accommodate 20 boys, was therefore hired, and has been occupied since last November, 20 boys being lodged and boarded; the latter item at the cost of only 4d. a head per day, the total weekly expenses being about £4. The total disbursements of the year, including those for furniture and other preliminary expenses, amounted to about 7,500 lire.

SELF-WINDING CLOCK.—In September last, a new perpetual clock was put up at the Gare du Nord, Brussels, in such a position as to be fully exposed to the influence of wind and weather; and although it has not since been touched, it has continued to keep good time ever since. The weight is kept constantly wound up by a fan, placed in a chimney. As soon as it approaches the extreme height of its course, it actuates a brake, which stops the fan; and the greater the tendency of the fan to revolve, so much the more strongly does the brake act to prevent it. A simple pawl arrangement prevents a down draught from exerting any effect. There is no necessity for a fire, as the natural draught of a chimney or pipe is sufficient; and if the clock is placed out of doors, all that is required is to place above it a pipe, 16 or 20 feet high. The clock is usually made to work for 24 hours after being wound up, so as to provide for any temporary stoppage; but by the addition of a wheel or two, it may be made to go for eight days after cessation of winding. The inventor, M. Auguste Dardenne, a native of Belgium, showed his original model at the Paris Exhibition of 1878; but has since considerably improved upon it.

PURE CARBONS FOR THE ELECTRIC LIGHT.—At the meeting of the Paris Academy of Science on 27th March, M. Jacquelain pointed out that carbon for the electric light should be purer than that obtained by calcining wood; and, if not free from hydrogen, should, at any rate, contain no mineral impurities. There are three methods for accomplishing this result:—(1) By the action of a jet of dry chlorine gas directed on the carbon, raised to a light red heat; (2) by the action of potash and caustic soda in fusion; and (3) by the action of hydrofluoric acid on the finished carbons. M. Jacquelain has prepared carbons by all three methods, and has summed up, in a table, the photometric results of his experiments. He comes to the conclusion that the luminous power and the regularity of the voltaic arc increase in direct ratio to the density, hardness, and purity of the carbons. He remarked, incidentally, that the natural graphitoïd of Siberia possesses the singular and unexpected property of acquiring, by purification, a luminous capacity double that which it has in the natural state, and which exceeds by one-sixth that of pure artificial carbons.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 26...London Anglers' Fisheries Association (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Mr. R. B. Marston, "The Propagation of our Fresh-water Fish."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Commander V. L. Cameron, "A Sketch Survey of the Ancobra and Prince's Rivers, and of the Takwa Range, Gold Coast." 2. Captain R. F. Burton, "The Kong Mountains."

TUESDAY, JUNE 27...Statistical, Somerset-house-terrace, Strand, W.C., 4 p.m. Annual General Meeting.

Anthropological Institution, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. Villiers Stuart, "Note on some Egyptian Antiquities." 2. Dr. Becher, "Some Mexican Terra-Cotta Figures." 3. Mr. E. H. Man, "The Aboriginal Inhabitants of the Andaman Islands." Part III.

WEDNESDAY, JUNE 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.

Public Analysts, Burlington-house, W., 8 pm. 1. Mr. W. Johnstone, "Samples of Milk which have fallen below the Society's limit." 2. Mr. O. Hehner, "The Relation between Specific Gravity, Fat and Solids not Fat in Milk;" and "New Analysis of the Sandrock (I.W.) Mineral Water." 3. Mr. G. Wigner, "The Work Done by Public Analysts during 1881, under the Sale of Food and Drugs Acts." 4. Mr. T. P. Blunt, "Note on the Use of Platinic Chloride as an Indicator in the Determination of Free Iodine."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. A. Marks, "The History of Leonardo de Vinci's Cartoon of St. Anne and the Virgin, now in the possession of the Royal Academy."

THURSDAY, JUNE 29...Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Third Conversazione.

Royal United Service Institute, Whitehall-yard, 3 p.m. Captain H. J. Fletcher Campbell, "Naval Brigades."

SATURDAY, JULY 1...Geologists' Association, University College, W.C. Excursion to Croydon under the direction of Prof. Morris and Mr. Klassen.

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FRIDAY, JUNE 30, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXHIBITION OF MODERN ENGLISH POTTERY.

The Exhibition will close on Saturday, July 1st. An illustrated notice of the Exhibition will be published in a future number of the *Journal*.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the report from the Council, and the Treasurers' Statement of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 28th of June, at four p.m., Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society :—

Arkinstall, Charles, Highfield, West Bromwich, Staffordshire.
Blyth, James, 2, Park-crescent, Regent's-park, N.W.
Bohn, Henry, 142, Holland-road, Kensington, W.
Bryan, William Booth, Woodfield, Blackburn.
Chance, Alexander M., Alkali Works, near Birmingham.
Chaplin, James Charles, 3, Temple-gardens, E.C.
Dawson, William, Almora-house, The Mall, Chiswick.
Earle, Major-General William, C.S.I., 8, Eaton-place, S.W.
Freakley, William, 41, Pyenest-street, Shelton, Staffordshire.
Gillett, William Arthur, Harefield, Bittern, near Southampton.
Goulding, William, Summerhill-house, Cork.
Graham, William Coryton, 18, Prince of Wales-terrace, W.
Gregory, John Waterson, Bedminster High School, Bristol.
Grier, W. F., 20, Stamford-street, Blackfriars, S.E.
Higgin, George, Broadway-chambers, Westminster S.W.
Hill, John, Ennis, Co. Clare, Ireland.
Hirst, Godfrey, 42, Baxtergate, Whitby.
Holdsworth, James, 35, Gresham-road, Brixton-road, S.W.
Hulse, William Wilson, The Grove, Withington, near Manchester.
Humphrys, James, Anglo-American Brush Light Corporation, Limited, Belvedere-rd., Lambeth, S.E.
Jamieson, Alexander, 24, St. Mark's-crescent, Regent's-park, N.W.
Jesseman, Alexander, Old College, Woolwich.
Kincaid, Joseph, B.A., 11, Great George-street, S.W.
Kinipple, Walter Robert, 2, Westminster-chambers, S.W., and Whitefarland, Greenock, N.B.
McNay, Thomas Fothergill, 41, Parliament-street, S.W.
Maitland, Colonel Eardley, R.A., Royal Arsensal, Woolwich.
Marshall, Miss Sarah, 72, Warwick-gardens, Kensington, W.
Mitre i Vedia, Emilio, Buenos Ayres.
Mixer, Robert, 7, Keith-grove, Uxbridge-road, W.
Mylne, James, Osborne-house, Holland-park, W., and Beheea, Shahabad, Bengal.
Noble, Captain Andrew, C.B., F.R.S., Elswick Ordnance Works, Newcastle-on-Tyne.
Ondadje, Dr. W. C., Ceylon, and 15, Chantry-road, Stockwell, S.W.
Osborn, Samuel, Sheffield.
Shore, Lieut. the Hon. Henry N., R.N., Coastguard, Greenock, N.B.
Silvester, John, Sandilands, Towyn, Merionethshire.
Sutherland, W. G., 1, St. James's-square, Manchester.
Tudor, Edward Charles Buchanan, Goole, Yorkshire.
Van der Weyde, Henry, 182, Regent-street, W.
Wills, Herbert, 53, Merehall-st., Bolton, Lancashire.
Wolfen, Chevalier, 16, Fopstone-road, Earl's-court, S.W.
York, Francis Colin, 28, Calverley-street, Tunbridge-wells.

The CHAIRMAN nominated Mr. W. Botly and Mr. H. Liggins scrutineers, and declared the ballot open.

The SECRETARY then read the following—

REPORT OF THE COUNCIL.

I.—Ordinary Meetings.

The first ordinary meeting of the Session took place on the 16th of November, and at this, as usual, an opening address was delivered by the Chairman of the Council.

Sir Frederick Bramwell's address took the form of a description of the various recent applications of science to the promotion of Arts, Manufactures, and Commerce. Among all these developments of practical science, there is no question but that the applications of of electricity to purposes of daily life are those which are now attracting the largest amount of public notice. It is a natural consequence of this, that special attention has been paid to the subject in the papers which have been read at our ordinary meetings during the past Session. At the first meeting after the Chairman's address, the subject was an electrical one; a very excellent paper, on "The Storage of Electricity," having been read by Professor Silvanus Thompson. There are few points which have roused more curiosity among the part of the public who are not necessarily conversant with scientific matters, than the question whether it was possible to store up energy in such a way that it might produce electric currents. The progress which has been made towards the attainment of this result was clearly shown by Professor Thompson, who traced the history of the subject up to its then most recent development, in the accumulator of M. Faure. A little later in the Session, Mr. W. H. Preece read a paper on the Paris Electrical Exhibition, which had been closed a month or so before. The meeting was specially notable, because, on this occasion, for the first time, the Edison system of lighting was completely illustrated before an English audience. Owing to the kindness of the Edison Company, and especially of their able representative in this country, Mr. E. H. Johnson, the whole system was most fully exemplified. The room was lighted up with Edison incandescent lamps, fitted with all the proper safety appliances, while the electricity itself was generated by means of an Edison machine (one of the only two at that time in this country), driven by a steam-engine placed at a little distance from the Society's premises. There was one more paper dealing with electric lighting, which was read near the end of the Session, by Mr. Thos. Bolas, the subject being the "Fire Risks Incidental to Electric Lighting." On the introduction of the electric light, many who had not sufficiently considered the subject, assumed that there were no risks whatever attendant upon its use, and to such persons it was a discovery that enormous heat and brilliant light could not be produced at one point of an electric circuit without a certain risk of heating or firing at other points of the circuit. Hence came a reaction, which gave rise to the notion that electric-lighting was even more dangerous than gas-lighting. This had its effect upon the insurance companies, some of which seemed, in the general ignorance existing as to the actual amount of danger arising from this cause, almost reluctant to accept insurances for buildings lighted with the electric light. Under these circumstances, it was obvious that good could not but arise from a public discussion of the question, and Mr. Bolas's paper, with the discussion upon it, has already borne fruit in the formation of an influential committee of the Society of Telegraph Engineers and Electricians to consider this most important question. But if the application of electricity to lighting purposes has received its due share of attention in our proceedings, its other great novel application, to the transmission of speech, has not been neglected. In April last, Colonel Webber, a member of the Society's Council, brought before the Society the present condition of telephonic communication. Previous papers, since that remarkable one in which Professor Bell described his invention to the Society, have dealt with the scientific side of the question. Colonel Webber dealt with the industry which is now so rapidly extending itself in all our great cities. Many of his suggestions deserve, and will doubtless receive, the attention of those who are now engaged in providing the public with this most convenient means of speedy communication.

It has been a common remark that the increased amount of light supplied in the public thoroughfares and elsewhere by means of electricity, has caused a natural demand for a greater supply of artificial light generally. This demand in London and elsewhere has been, to a large extent, met by improved methods of gas illumination. Here, again, was a question on which it seemed desirable that the members of the Society should have the latest views of men of science brought before their notice, and it was a satisfaction to the Council that so able an authority as Professor Vernon Harcourt accepted their invitation to read a paper before the Society on the subject. Professor Harcourt had the benefit of the assistance of most of those firms who are now engaged in the manufacture of improved appliances for burning gas—Messrs. Sugg, Messrs. Siemens, Messrs. Bray, and others—so that not only was the theory of the subject clearly brought before the members in the paper, but those who attended had an opportunity of seeing and comparing for themselves the most recent and best apparatus of the sort. Another application of gas formed the subject of Mr. J. R. Wigham's paper. Mr. Wigham has long been known to lighthouse engineers and others interested in the subject as the principal advocate of the use of gas for lighthouse illumination. Mr. Wigham consistently maintained its superiority alike for the largest lights, where the electric light is generally preferred, and for the smaller lights, which are, at all events in this country, for the most part produced by burning some sort of oils. Mr. Wigham's paper, which was presided over by Dr. Tyndall, was fully illustrated by an exhibition of some of the beautiful apparatus, devised by the writer, for the production of gas flames of enormous power. Mr. J. Emerson Dowson treated of an application of gas to totally different purposes, namely, those of heating and of providing motive power. Mr. Dowson has for some time past been engaged in the production of a cheap gas made by injecting a current of steam and air into a furnace, the result being a product which, if not suitable without further treatment for lighting, is admirably adapted either for heating purposes, or for supplying gas-engines. According to the statement put forward by Mr. Dowson in his paper, great economy has been effected by the use of gas thus made in driving an engine of the well known Otto type, an economy even comparable with that of the best steam-engines.

Of all the subjects with which the public mind has been lately much exercised, perhaps, none (of a non-political character) has given rise to so much controversy as the Channel Tunnel; and the importance of ready intercommunication of nations in its bearing upon Arts, Manufactures, and Commerce will, the Council believe, have amply justified their invitation to Sir Edward Watkin to open a discussion on this subject before the Society. The discussion, thus commenced, was continued over two evenings, and excited the very greatest interest among the members. Both parties, the promoters of the Tunnel and its opponents, were ably represented, the former by Sir Edward Watkin, Lord Brabourne, and many of those associated with Sir Edward in the project, and the latter by Lord Dunsany and Admiral Sir John Hay, amongst others.

The supply of fish to London is a subject with which the Society has dealt almost since its foundation, and it would have been difficult for the present state of the question to have been more clearly put before any meeting than was done by Mr. Spencer Walpole, who, spoke with all the authority derived from his long experience as Inspector of Fisheries.

Not less important than the supply of food is its preservation; and the antiseptic compound of borax and glycerine which Professor Barff introduced to the public through the medium of the Society, is likely to form a valuable means of increasing our food supplies, so soon as it shall have passed from the laboratory into commerce. Few of the subjects introduced this Session at the Society have attracted more attention than this.

Another matter of importance, alike to London and to all other great cities, is the supply of water. A special department of this subject—the means for providing a constant and abundant supply, without permitting useless waste—was treated of by Mr. G. F. Deacon. Mr. Deacon is specially known to the engineering world by the admirable mechanical arrangements he has made for detecting and preventing waste where water is constantly supplied at a considerable pressure. He has devised a meter which records with minute accuracy the quantity of water passing through it, and does so without offering any obstacle to the passage. Recording, as it does, the slightest increase or diminution in the demand, it is not difficult to see that a diagram showing, in addition to these varying demands, any absolutely constant flow, must of necessity indicate waste, there being, as a rule, no useful purposes for which water is supplied with absolute uniformity, day and night. An instrument itself was set to work in the Society's room, and by an ingenious apparatus, instead of tracing a diagram on the ordinary rotating drum, it was caused to trace one upon a plate of smoked glass placed in front of an oxy-hydrogen lantern, by means of which the tracing was projected upon a screen, so as to be visible to the entire audience.

In his Opening Address, Sir Frederick Bramwell apologised for introducing a description of certain improvements in the construction of warlike apparatus, but justified the introduction on the ground that commerce knew few greater necessities than the necessity for its defence. If any excuse were needed for the invitation which the Council addressed to Colonel Maitland, to read a paper on the manufacture of ordnance, this excuse might, perhaps, again be pleaded; but the subject would certainly come legitimately within the scope of the Society's work, inasmuch as the manufacture of ordnance requires the application of a knowledge of the most important scientific principles, and principles which are available also for more peaceful purposes.

The arrangement now at work in Paris for "distributing" time by a system of pneumatic clocks, was described to the Society by M. Berly, who is associated with the Paris Company. This, like so many of the papers which have been read this Session, was illustrated as fully as it was possible to do, by setting up a complete system in the Society's room. Time was actually "distributed" by a governor clock at one corner of the room, supplied from a reservoir of compressed air, to a great number of clocks placed all round the walls, a sufficient length of piping being introduced, to provide the amount of frictional resistance which would be found in a mile or two of such main, if laid down in the streets.

During the winter, Captain Douglas Galton described to the Society the American system by which whole towns are heated by steam from a central station. In a recent journey in the States, Captain Galton had had his attention specially drawn to the system, and he was consequently in a position to bring before the members much valuable information as to its working.

The papers dealing with applications of Art have been less numerous than in some former Sessions. Mr. Hulme read an interesting and suggestive paper on "The Relation of Botanical Science to Ornamental Art," and Mr. L. F. Day read one a little later in the Session upon "Stained Glass Windows," in which the history and present state of the glass-painter's art, were fully treated. Two papers, dealing with economical subjects, were read during the Session—one on "The Industrial Resources of Ireland," by Mr. Phillips Bevan, and one on "The Causes and Remedies of Bad Trade," by Mr. Walter R. Browne.

A paper by Colonel Pearson, on "The Teachings of Forestry," drew attention afresh to a department of education in which there seems no question but that this country is behind other nations. A committee on the subject has been appointed by the Council, and it is hoped that such representations may be made to the Government as will result in the removal of a disability which certainly appears to exist.

The question of technical education, which has been dealt with so frequently, and in so many forms, by the Society, has not been altogether lost sight of at our meetings this year, for Mr. Robins, one of the most active members of the City and Guilds Institute Committee, gave us the results of a recent tour he had made in Germany, with the special object of inspecting the various establishments in that country for the promotion of scientific and technical instruction.

A paper by Mr. J. Spencer Curwen contained an account of that system of teaching music which has attained so much popularity in this country, under the title of Tonic Sol-fa. Musical education has of recent years absorbed a good deal of the attention of the Society, and it seemed only fitting that this branch of it should receive due notice.

In connection with Mr. Hasluck's paper on the Lathe, a very choice selection of examples of ornamental turning was shown, as was also some fine apparatus for executing work of this character.

At the last meeting of the Session, Captain Richard Burton, who has recently returned from the Gold Coast of Africa, gave a most interesting account of the expedition undertaken by himself and Commander Cameron, an expedition undertaken principally with the object of ascertaining how far it may be possible to obtain gold, in larger quantities than has hitherto been the case, from that country. Gold has, in comparatively small amounts, for a long time been brought from the West Coast of Africa—indeed, the earliest name of the district (the Gold Coast) is sufficient to show this. According to the opinion expressed by Captain Burton, there is no reason why the supply should not be largely increased, the main difficulty being the supply of labour. One of the most important points raised in the discussion related to the healthfulness of the coast, and considerable evidence was brought forward by those familiar with the country, to show that the bad name it has acquired is hardly deserved, at all events, when proper precautions are taken to preserve health.

It will have been noticed that a special feature of the papers which have been read this Session, has been the very extensive way in which they have been practically illustrated. When so much has been done, it is difficult to particularise, but the Council feel that the special thanks of the Society are due, not only to the readers of such papers as those by Mr. Berly, Colonel Maitland, Mr. Vernon Harcourt, Mr. Wigham, Colonel Webber, Mr. Bolas, and Mr. Deacon, for the trouble and expense to which these gentlemen were put in providing experimental illustrations, but also to various firms who have kindly, during the Session, lent apparatus for the purpose. Foremost amongst these must be mentioned the Edison Company, which, on several occasions, most liberally provided apparatus for the use of readers of papers or lecturers here. Messrs. Robey also, twice, were kind enough to lend us one of their portable steam-engines, to drive dynamo-machines, a kindness which they have shown, it will be remembered, in former Sessions. Messrs. Crossley Brothers lent for a considerable period one of their gas-engines; Messrs. Siemens Brothers for the same period lent a dynamo-machine and various other fittings. The kindness of some other firms has been before mentioned.

But though the Society has been saved much expense in the illustration of papers, by the assistance they have received, the Council have also felt themselves justified in spending rather more than has hitherto been the case, in thus adding to the interest of the meetings, for they feel that any reasonable outlay in this direction will be appreciated by the members. The Council are also glad to be able to say, as is stated with more fulness in the latter portion of this report, that the improved condition of the Society's finances justifies a liberal expenditure in such directions as those indicated.

It may be noticed that there were several papers announced at the commencement of the session, which, from various unavoidable causes, have not been brought forward. Amongst these, the Council must specially refer to the one by Mr. Loftus Perkins, on the "High Pressure Steam Engine." Mr. Perkins has been engaged during the year upon an improved form of one of his engines, from which such results of economy are being obtained, as it will be interesting to bring before the Society later on; but the experiments were not concluded in time for the preparation of a paper during the past Session.

II.—INDIAN SECTION.

The papers read this Session before the Indian Section of the Society have been up to the very high standing which the Section has always been fortunate enough to maintain. There was some disappointment owing to Mr. Pedder, of the India-office, being unable, from pressure of official work, to provide a paper on "Village Life and the Village System in the Bombay Presidency;" but this was made up for by the excellent papers which were read. At the first meeting, on the 13th January, a paper on "The Opium Trade," by Sir Rutherford Alcock, brought together a very numerous, influential, and interested audience. Sir Rutherford's practical experience enabled him to give what may be said to be the fullest and fairest account of the real state of the case as to the opium trade, and its effect both on the Chinese and on the Indian subjects of her Majesty, that is to be found in all the literature of the subject. The subsequent discussion, which was wisely controlled by Lord Aberdare, who was in the chair, brought out the principal arguments employed by those who so strongly condemn the traffic. At the second meeting of the Section a paper was read by Mr. Maclean, on "The Depreciation of Silver as it affects India." At this Sir Richard Temple presided. The paper was specially interesting, inasmuch as Mr. Maclean took quite a fresh view of the subject, showing that, in his opinion, while the loss by exchange was a very serious matter to Government and to British residents having occasion to remit to their families at home, yet to India itself it had really been an advantage, as tending greatly to increase export trade. The third paper, 21st April, Sir Joseph Fayrer in the chair, was an able epitome of "The Mineral Resources of India," by Professor Ball, late of the Geological Survey. The fourth, by Mr. Mylne, May 5th, read by Dr. Mouat, Sir George Campbell, M.P., presiding, was a most interesting and instructive account of the "Experiences of an English Zemindar (landholder) in India," showing in a striking and graphic manner the difficulties any reformer in agriculture has to contend with in India, and how they may be, and are being, gradually overcome by kindness, tact, and ability, in producing really profitable improvements which the natives can afford and appreciate ultimately. The fifth and last paper of the Section, by Mr. J. R. Royle, of the India-office, was an admirable *précis* of the latest authentic information regarding "The Production of Tea, Cinchona, Rhea, and Wild Silks in India."

III.—FOREIGN AND COLONIAL SECTION.

The first contribution to the Foreign and Colonial Section, this year, was a paper by Mr. William Cochran, advocating the combined cultivation of silk and tea in New Zealand, and urging the facilities that are available in that Colony for a successful prosecution of the industry. Mr. E. Hepple Hall next communicated an account of the present state of Newfoundland, describing its physical and geographical features, and its industries, and alluding to the direction in which the development of its resources may be most reasonably looked for.

This paper was followed by an account of the methods adopted for the advancement of "Scientific and Technical Education in Russia," in connection with which the author, Professor J. F. Hodgetts, of the Imperial College of Practical Science, in Moscow, argued for the adoption of a similar plan of teaching in England. Dr. Rae next gave a very interesting sketch of some of the native tribes of the Hudson's Bay Company's territories, enlarging upon their habits of life and social state, and testifying strongly to the many good qualities of his old friends, the Eskimos, of the North American Arctic Coast. Lieutenant the Hon. Henry N. Shore, of the Coast Guard Service, contributed a series of remarks on the character of the inhabitants of China and Japan, in which he claimed the merit of greater originality and intellectual power for the Chinese than is usually accorded to them, and insisted upon their manifest capacities as a colonising and civilising race, a view in which he was substantially supported by the testimony of Sir Rutherford Alcock, who, as President of the Section, occupied the chair at the reading of the paper.

The announcements for this Section included a paper by Captain Burton and Commander Cameron on "The Gold Fields of Western Africa." At one time it seemed probable that the travellers would not be back in England before the conclusion of the Session, but on their return, a few days before the date fixed for their paper, they promptly undertook to bring the question forward. Unfortunately, Captain Burton was seized with an attack of fever, and could not appear, and consequently, his paper had to be postponed to the last ordinary meeting of the Session. In the meantime Commander Cameron undertook to amplify his own share of the contribution, which accordingly was read to a full meeting of the Section on the 23rd May.

Dr. Mann, in a narrative of "Recent Passages in Zulu Kafir History," which was illustrated by a large series of original photographs, exhibited by the lime-light apparatus of the Society, gave reason for the hope of the ultimate civilisation of this interesting race, when freed from the cruel and barbarous rule to which they have been continuously subjected since the commencement of the present century, and urged the inexpediency of the restoration of the system of one supreme chieftainship in Zululand, in the interests of the natives themselves.

IV.—SECTION OF APPLIED CHEMISTRY AND PHYSICS.

The first paper brought before this Section was by Dr. Thudichum, who gave an account of the recent researches made by M. Pasteur and others into the "Theory of the Living Contagium," and the application of these researches to the prevention of certain diseases in animals. A special interest now attaches to this paper, inasmuch as it gives a record of the work of the distinguished French man of science to whom the Council have awarded the Albert Medal for the year. At the second meeting, Mr. Harold Dixon read a paper on "Photometric Standards." Mr. Dixon is secretary to the Board of Trade Committee appointed to consider the question of a standard for light, and his paper gave a useful account of the results of the investigations of this committee. One feature of the paper was the exhibition and description of Mr. Vernon Harcourt's standard gas flame, which has been adopted by the committee. Mr. Harcourt's investigation was brought before the Society in his Cantor Lectures upon Gas-making five years ago. At the next meeting Mr. Burton gave an excellent description of the most recent methods of making the dry gelatine plates, the use of which has effected so great a revolution in the art of photography. Mr. Burton's paper followed closely after the series of Cantor Lectures, by Captain Abney, on Photography, and dealt with a branch of the subject which the limited time at his command had compelled Captain Abney to pass over somewhat shortly. Mr. Warington's paper, which was the next, gave an account of the recent investigations in nitrification which have been carried on in Sir

J. B. Lawes's laboratory by the author. At the April meeting, Messrs. Thomas and Gilchrist gave the Society an account of the important process for the manufacture of iron from ores containing phosphorus, which was first brought out by them two years ago. The work of the Section concluded with an excellent paper, by Mr. Chance, on "The Recovery of Sulphur from Alkali Waste." Mr. Chance has been carrying out Schaffner's process on a large scale, in his works near Birmingham, and has obtained results, the value of which, in their effect upon a most important industry, it would be difficult to overestimate.

V.—Cantor Lectures.

The experiment which was tried last year of shortening the length of the course of Cantor Lectures, and providing a greater number of courses during the Session, proved so successful as to induce the Council to follow the same course this year. Consequently, there were four courses delivered. The first of these was on the "Industrial Uses of the Calcium Compounds," by Mr. Bolas. Mr. Bolas brought clearly before the members the very varied application of the different compounds of this most important metal, and illustrated their diverse uses by an elaborate and carefully devised series of experiments. The second course was by Captain Abney, on "Recent Advances in Photography." Those who are conversant with the art of photography know that in few of the applications of science has there been more marked progress of late years. In every branch of it there has been a rapid advance, while the number and extent of its applications are increasing. There could be no fitter exponent than Capt. Abney, to whom, indeed, is due no small portion of the recent advance which has been made. The result of the lectures quite fulfilled the anticipations of the Council. The course proved to be one of the most popular which has ever been delivered. On the evening of each of the four lectures the room was crowded, and the opinion, both of those who heard the lectures, and of the special technical journals devoted to photography, was unanimous as to their value and interest. In the third course, Professor Perry, since appointed Professor of Mechanics at the Cowper-street Schools of the City and Guilds Institute, gave an account of the most recent developments of hydraulic machinery. Familiar as is the subject to engineers, it is probable that the general public are far from being aware of the amount of work which is done by water; and Professor Perry's information was put in such a form that it will certainly have proved useful to many not before conversant with the subject. The fourth course of Cantor Lectures was on "Book Illustration," by Mr. J. Comyns Carr. Mr. Carr gave an interesting though brief historical *résumé* of what has been done for the illustration of books in past times, and also gave a clear and useful sketch of the very decided progress which has been made in various directions during recent years in this art.

VI.—Juvenile Lectures.

Mr. W. H. Preece, whose juvenile lectures, two years ago, attracted so much interest, was again good enough to deliver a short course during the last Christmas holidays. Mr. Preece's subject was, practically, a continuation of that on which he had previously lectured. In 1879-80, he treated of "Recent Wonders of Sound and Light," and last Christmas he described to his juvenile listeners the most recent developments of the electric light. It is hoped that such lectures as these may not only be of great interest to the young people who hear them, but that they may be of real and lasting profit, by inducing a taste in later years for genuine scientific study. It should be added that, as Mr. Preece was a member of Council, he could not receive anything for his labour except the vote of thanks which was unanimously passed to him by the Council.

VII.—Additional Meetings.

Besides the Ordinary and Sectional meetings there have been several additional meetings of the Society, at which matters of interest were brought forward. While the Photographic Exhibition was going on, a meeting was held, at which Mr. Van der Weyde, the well-known artistic photographer, explained to the members of the Society the arrangement he has invented for utilising the electric light for photographic portraiture. Mr. Van der Weyde's apparatus was fitted in the Great Room, and several portraits were taken by its aid during the meeting. A little later in the Session another subject, which though specially photographic, possesses also considerable scientific interest, was brought before a meeting of the Society. Mr. Muybridge, of San Francisco, has, as the members are aware, for some years past been experimenting on the possibility of photographing animals in rapid motion. The arrangement invented by him enables him to depict the actual attitudes assumed, say, by a horse, in any of his various paces, and it has thrown a new light upon the question of animal locomotion generally. Mr. Muybridge paid a visit to England during the spring, and readily consented to exhibit before the Society the latest results of his experiments. By means of an ingenious modification of the well-known toy, the zoetrope, Mr. Muybridge has succeeded in throwing upon a screen, by the use of a powerful light, the figures in actual motion Thus, a horse is represented as trotting or galloping across the field of view. This re-combination of the various attitudes photographed affords the clearest proof, if proof were necessary, of the accuracy of Mr. Muybridge's work. His lecture on this subject was listened to with great interest. Its publication in the *Journal* was, at the special request of Mr. Muybridge, deferred, and it appeared in last week's number. Later in the Session, on the 28th April, Dr. Richardson delivered, before an afternoon meeting, a lecture on the subject of "National Education." Dr. Richardson brought prominently forward the necessity for physical education, and explained the injury to children arising from its neglect.

VIII.—ALBERT MEDAL.

The Albert Medal of the Society for the present year has been awarded to Monsieur Louis Pasteur, the distinguished French chemist, for "his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine making, silk production, and agriculture, have been greatly benefited." M. Pasteur's researches are well known, both in this and his own country, and they were brought prominently before English men of science by the paper read by him last year at the Medical Congress in London. His investigations have already had important applications in their results upon the industries connected with silk and with wine, and there seems little doubt that they are beginning to have results still more important in their application to the diseases of domestic animals. There is every reason to hope that our food supplies will be materially increased by this means, and though the yet further application of M. Pasteur's discoveries to the prevention of human disease does not come within the range of work which the Society can recognise in its awards, yet the hope may be expressed that this also may be included amongst the benefits conferred upon us by the labours of the distinguished man to whose honours the Council are glad to be able to add the highest honour which the Society of Arts can bestow.

IX.—MEDALS.

The Council have awarded eleven Silver Medals to the authors of papers read during the past Session. Of these, seven have been for papers read at the Ordinary Meetings, three for papers read in the Section of Applied Chemistry and Physics, and one for a paper read in the Indian Section. It should be noted that the paper for which Capt. Burton was awarded a medal, though actually read on a Wednesday evening, would, but for unavoidable circumstances, have been read in the Foreign and Colonial Section. The Council have always considered it undesirable that they should award medals to any members of their own body, and amongst the papers read during the past Session there were four, the importance of which they were precluded by this rule from recognising otherwise than by a vote of thanks. The papers in this category were by

Captain DOUGLAS GALTON, C.B., F.RS., on "The American System of Heating Towns by Steam."

By W. H. PREECE, F.R.S., on "Electric Lighting at the Paris Electrical Exhibition."

By Lieut.-Colonel C. E. WEBBER, R.E., on "Telephonic Communication."

By Sir RUTHERFORD ALCOCK, K.C.B., on "The Opium Trade."

The following is a complete list of the awards :—

To Professor SILVANUS THOMPSON, D.Sc,, for his paper on "Storage of Electricity."

To J. EMERSON DOWSON, for his paper on "The Production and Use of Gas for Purposes of Heating and Motive Power."

To Colonel G. F. PEARSON, for his paper on "The Teaching of Forestry."

To Professor BARFF, M.A., for his paper on "A New Antiseptic Compound, and its Application to the Preservation of Food."

To SPENCER WALPOLE, for his paper on "The Fish Supply of London."

To GEORGE F. DEACON, for his paper on "The Constant Supply and Waste of Water."

To Captain RICHARD F. BURTON, for his paper on "Gold on the Gold Coast."

To R. WARINGTON, for his paper on "Some Practical Aspects of Recent Investigation in Nitrification."

To S. G. THOMAS and PERCY C. GILCHRIST, for their paper on the "Manufacture of Steel from Phosphoric Pig-iron."

To ALEXANDER M. CHANCE, for his paper on "The Recovery of Sulphur from Alkali Waste by Schaffner's Process, a record of recent results."

To JAMES MYLNE, for his paper on "Experiences of an European Zemindar (landholder) in Behar."

X.—PATENT-LAW.

An account of the progress which had been made by the Society towards a reform of the Patent-law was given in the last Annual Report. It was then stated that the Council had appointed a Committee to prepare a Bill, and that it was hoped the Bill would soon be in a condition to be brought before the notice of the members. Not very long after the Annual Meeting, a special meeting of Council was called to consider the Bill, which had been completed by the Committee. After a draft had been approved by the Council, it was published in the Society's *Journal*,* and copies of the Bill were also circulated amongst those most likely to afford useful advice towards its amendment. Sir Frederick Bramwell, the Chairman of the Council, himself brought it under the notice of a meeting of the British Association at York; it was also discussed by other scientific societies in different parts of the country, and received a large amount of criticism from the technical press. On the 2nd December, the Bill was submitted to a meeting of the Society, and at this and adjourned meetings, it was fully discussed, especially by Sir James Fitzjames Stephen, and Mr. Richard Webster, Q.C., than whom it would be difficult to find more competent authorities, and they, while approving of much that was in the Bill, dissented from the proposal to establish a separate tribunal for the trial of Patent actions. After this full public discussion, the Committee again set to work upon the Bill, and varied it in accordance with the many valuable suggestions which had been made. After long and careful consideration, first by the Committee, and afterwards by the Council, the Bill was introduced into the House of Commons, and for this purpose the Council were fortunate enough to secure the valuable assistance of Sir John Lubbock, Mr. W. H. Smith, and Mr. J. C. Lawrance, Q.C. The Bill was read a first time on the 15th March, and a second time on the 28th April, Sir John Lubbock stating, on the latter occasion, that should the House assent to the second reading of the Bill, he would defer further action, in order to move that the Bill should be referred to the same committee to which it was understood the Government Patent Bill, when introduced, would be referred. So the matter now rests. In the present state of legislation, it is hopeless to expect that even if the Government Bill be introduced at all, any progress can be made in Patent legislation during this Session.

The Council feel, however, that they have every reason to be satisfied with the progress the Bill has made on its first appearance. They would indeed have been glad, had it been able to receive from a Select Committee of the House the full consideration which they believe it deserves; but should it, as is unfortunately but too likely, have to participate in the fate of many of the other abortive Bills of the Session, they will not fail to use their best exertions in order to bring it forward next year. Before quitting the subject, the Council wish to testify, in the most emphatic manner, to their appreciation of the care and thought which Sir Frederick Bramwell and Mr. Alfred Carpmael, together with the other members of the Committee, have given to the preparation of the Bill. Besides the actual meetings of the Committee—and they have been frequent and long—Sir Frederick and Mr. Carpmael have spent many hours of hard work in conference with Mr. Fitzgerald, the draughtsman of the Bill. Putting aside measures introduced by the Government for the reform of the Patent-law, it may safely be said that no Patent Bill introduced by a private member has ever approached in completeness the Bill of the Society of Arts. The Council think the members should understand that the chief merits of the proposed measure, and they believe it has many, are principally due to the care bestowed upon it by their Chairman, who, as the members are well aware, has made this subject a special study.

XI.—PHOTOGRAPHIC EXHIBITION.

In connection with the series of Cantor Lectures above referred to, delivered by Captain Abney, an Exhibition was held of photographic apparatus, and of specimens illustrating recent progress in the application of photography to reproductive processes. The Council were fortunate enough to secure, not only a good collection of modern apparatus, but also an interesting series of specimens, illustrating the progress of photography from its very earliest stages. The number of visitors attracted to the Exhibition was far larger than might have been anticipated, and in every respect the Exhibition proved a most gratifying success. The experiment is likely to have some permanent results, since it has been announced that the authorities of the South Kensington Museum intend to form a collection of illustrations connected with the history of photography. It is to be hoped that steps to carry out this intention may be taken without much delay, inasmuch as specimens of early photographic processes are year by year becoming more scarce. Many such specimens have already disappeared, as, though possessing great historical interest, they are often of no artistic value, and consequently, when they pass into the hands of persons not specially familiar with the subject, they are often thrown away or destroyed. The first generation of photographers has now but few members left, and in a few years more, it will be impossible to form such a collection of their works as might at the present moment be got together without any very great difficulty.

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* No. 1,498, August 5th, 1881.

XII.—ART FURNITURE EXHIBITION.

An account of the Art Furniture Exhibition, held last summer at the Albert Hall, on the initiative of the Society of Arts, was given in the Annual Report for last year. At the time of the issue of the Report, however, the award of medals and certificates to the workmen employed on the manufacture of the exhibits had not been made. Since then, the Committee appointed by the Council reported, recommending the award of 19 medals and 13 certificates. The Council adopted the Report, and presented medals and certificates in accordance with it. The Report, comprising a list of the successful competitors, has already appeared in the *Journal*.

XIII.—POTTERY EXHIBITION.

During the latter part of the Session, the Council have been able, by the assistance of the principal manufacturers, to hold in the Society's House a very interesting Exhibition of Modern English Artistic Pottery. The space at the disposal of the Council was too small to admit of any general invitation to manufacturers being issued, and, therefore, they adopted the plan of asking a few of the principal firms to send typical examples of their manufactures. One or two of the firms addressed by the Council were unable, for various reasons, to accept the offer, but all the others did so, and the result has been an extremely good representative Exhibition of the present state of the manufacture of artistic pottery in this country. Messrs. Brown-Westhead & Co., sent some fine examples of their large ivory ware. Messrs. Doulton showed a collection of the well-known Doulton stoneware, some earthenware, and a collection of Lambeth faïence and impasto wares. Mr. Harrison showed a number of specimens of Linthorpe ware, made from the ordinary red clay found at Middlesborough-on-Tees. Messrs. Maw exhibited specimens of their tiles and other ware. Messrs. Minton showed some very fine examples of their manufactures, including *pâte sur pâte* decoration, imitation Sèvres, copies of Henry Deux ware, &c. Messrs. Wedgwood & Sons showed applications of Wedgwood ware to household decoration, a copy of the Portland vase, and other examples of their work. The Worcester Company sent a varied collection, showing the different sorts of work now produced at their potteries.

The Exhibition has attracted a good deal of attention, and has been fairly well visited. The members, indeed, have not availed themselves so largely as might have been expected of the opportunity of admitting their friends to the Exhibition; but the attendance has certainly been such as to encourage the Council in holding Exhibitions of this sort.

XIV.—EXAMINATIONS.

It will be in the recollection of the members that in 1879, the determination was arrived at by the Council to discontinue the Society's Commercial Examinations, and they were accordingly discontinued after 1880. In the course of the present Session some of the Institutions in Union addressed an application to the Council, asking that these Examinations might be resumed. The memorialists urged very strongly the importance of this branch of the Society's work, and stated that the loss had been seriously felt. The Council, after carefully considering the matter, decided that it would be well to comply with the application, and to renew the Commercial Examinations. Notice was accordingly given that they would be at once resumed, and arrangements were made for holding the Examinations during the latter part of the present month. The notice was, of course, short, and consequently, it was not to be expected that many candidates would offer themselves; still, a certain number came forward, and possibly next year the numbers may be sufficient to show that the memorialists were justified in their application. Next year the experiment will be tried on a more extended basis, and a fairer test will be provided of the value attached to these Examinations by the classes for whom they are provided. As in former instances, the Council have to express their appreciation of the assistance they have received from the Science and Art Department. The Department has consented to allow the Examinations to be held in conjunction with its own, and the arrangements have been greatly simplified by the Society being able to avail itself of the existing organisation of the Department. The Examinations in Domestic Economy, Political Economy, and Theory of Music, were held in May, but as the returns have not yet, in all cases, been received from the Examiners, it is not possible to say what their results have been.

XV.—Examinations in Practical Music.

Local Examinations have been held through the agency of the Society this year in Glasgow, Birmingham, and Liverpool—the last-named a new centre. Examinations were also held at the Society's House in July and in January. The Society's Examiners, Dr. Hullah and Mr. Barrett, speak favourably of the progress of these Examinations, reports upon which have peared, or in due course will appear, in the Society's *Journal*.

XVI.—House Sanitation.

It was announced in the last Report of the Council that three silver medals had been offered for the best sanitary arrangements in houses within the metropolitan area, and the conditions were then stated under which the offer was made. The Committee appointed by the Council, after examining the plans of the houses submitted in competition, and, when they considered it desirable, inspecting the houses themselves, recommended an award of the medal offered for a house of the yearly rental of £200, to Sir Daniel Cooper, Bart., K.C.M.G., in respect of his house, No. 6, De Vere-gardens, Kensington. They further recommended the award of the medal offered for a house of a yearly rental of between £40 and £200 to Captain Charles Andrew, in respect of his house, No. 286, Kennington-park-road; and they also recommended that a medal should be given to Mr. S. E. Mineard, for his house, No. 169, Philbeach-gardens, Earl's-court, in consideration of an ingenious method adopted by him of securing a constant current of air through the house drains, by means of a gas jet continually burning in a ventilating pipe. No houses in the third category, that is to say, houses let out in tenements to artisans, for which a weekly rental is paid, were submitted for competition. The Council, acting on the report of the Committee, have, therefore, only awarded the three medals as above stated.

XVII.—Owen Jones' Prizes.

These prizes are provided by the interest on the sum of £400, presented to the Society of Arts by the Owen Jones Memorial Committee to students of the Schools of Art, who produce the best designs for household furniture, &c., on the principles laid down by Owen Jones. The prizes are awarded on the results of the annual competition of the Science and Art Department. Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal. A list of the successful candidates has appeared in the *Journal*.

XVIII.—Plant Label.

It was stated in last year's Report that Mr G. F. Wilson. F.R.S., had placed at the disposal of the Council of the Society, a prize, of the value of £5, for the best label for plants. The Committee who considered the labels sent in in competition, reported favourably of many of them, but did not consider that any were of merit sufficient to entitle them to the award of the offered prize. They therefore recommended that the offer should be renewed for the present year, and Mr. Wilson expressed his readiness to place the money at the disposal of the Council again. Announcements to this effect were made, and upwards of sixty sets of labels have been received in response. These are now under the consideration of the Committee, who will report upon them in due course.

XIX.—Education in Forestry.

The paper previously referred to on this subject, read at one of the ordinary meetings by Colonel Pearson, drew the special attention of the Council to the necessity for better education in Forestry. It may not be known to the members generally, that the engineers required for forest conservancy in India have all to be trained in foreign schools, which are practically subsidised for the purpose by our Government. Not only is there a considerable demand in India for persons qualified to take charge of forests, but it is believed that even at home there is a good deal of work which might be usefully accomplished in this direction. The Council have therefore appointed a Committee to consider the matter, and see whether they could not usefully draw the attention of the Government to some scheme by which suitable education might be provided in Forestry in this country.

XX.—MEMORIAL TABLETS.

During the past Session the Council have considered the advisability of erecting memorial tablets in honour of the following distinguished men, and they are now in communication with the owners of houses on which it is proposed that the tablets should be placed:—Henry Cavendish, Sir Humphry Davy, Charles Dickens, Thomas Gainsborough, Count Rumford, Percy Bysshe Shelley, Joseph Mallord William Turner, and Josiah Wedgwood. It is hoped that arrangements may, in most of the above cases, soon be completed.

XXI.—AUSTRALIAN EXHIBITIONS.

After the closing of these Exhibitions the Royal Commissioners made a request to the Society that a set of Barry's etchings might be presented to the National Gallery of South Australia, at Adelaide, in addition to the sets that had previously been presented to the National Gallery of New South Wales, at Sydney, and to the National Gallery of Victoria, at Melbourne. The Council had pleasure in complying with this suggestion, and a set of the etchings was accordingly sent through the Royal Commission to the National Gallery at Adelaide. Barry's painting, which had been lent to the Exhibitions, has been safely returned, and has been again replaced in the South Kensington Museum.

XXII.—BARRY'S PICTURES.

It has been considered desirable that, in order to ensure the preservation of these remarkable works of art, they should be carefully looked to every year. During last summer they were accordingly carefully dusted over. The cleaning which they underwent, in 1880, has much improved their condition, and it is hoped they may remain in an equally good state for many years to come.

XXIII.—SOANE MUSEUM.

The Act of Parliament under which Sir John Soane's Museum in Lincoln's-inn-fields was established in 1833, provided that trustees should be nominated by certain bodies, of whom the Society of Arts is one. A fresh trustee has to be elected every five years, and at the last election Mr. Alan Cole was appointed in succession to Mr. Samuel Redgrave. The Council have now placed on the balloting list the name of Dr. Richardson to fill the vacancy.

XXIV.—MEMORIAL WINDOW.

The members are aware that in 1872 the amount of £343 was subscribed for the erection of a memorial window in St. Paul's Cathedral, to commemorate the recovery of H.R.H. the Prince of Wales from his serious illness. A design for the purpose was prepared, but owing to various difficulties, it was found impossible to arrange for the erection of a window in agreement with this design. At the end of the last Session, the Council renewed negociations with the Dean and Chapter as to the best way of disposing of the amount, and it was finally resolved that the amount subscribed should be placed at the disposal of the Dean and Chapter of St. Paul's, to be expended upon a stained-glass window in such manner as the Dean and Chapter should decide. The Dean expressed his willingness to receive the money, and accordingly the amount of the fund subscribed has been handed over to him.

XXV.—NATIONAL TRAINING SCHOOL FOR MUSIC.

This institution, founded through the agency of the Society in 1873, opened in 1876, and carried on from that date until Easter last, has now been closed, and the balance of its funds transferred to the fund which is being collected for the establishment of a Royal College of Music.

The fifth and last General Report of the school, bearing date Easter, 1882, has recently been issued. It is preceded by a short statement, which takes the form of a dedication addressed to H. R. H. the Prince of Wales by H.R.H. the Duke of Edinburgh, the President of the Committee of Management of the school. This statement gives an account of the excellent work which has been carried out by the school during its short term of existence, and shows that the actual results it has accomplished are such as to justify the efforts of those by whom it was founded and of those by whom it has been carried on. The total funds administered by the school from December, 1875, to April, 1882, amounted to £22,607. Of this, £21,493 was expended, thus leaving a balance of £1,114. £1,100 of this balance has (as above stated) been paid to the Royal College of Music. It may be worth while to mention the fact that the balance-sheet deals only with the sums received and expended by the committee of the school, and does not, of course, take any notice of the amounts paid by the Society for the school prior to its opening. As a fact, the Society, in 1873, and the three years following, paid away £956, besides providing for the scholarships founded by it. The greater part of this sum of £956 was used in promoting the endowment of provincial scholarships. The Society's scholarships amounted in the five years to £800, so that since the foundation of the school in 1873, the Society has contributed to it £1,756. Before 1873, £217 was spent by the Society's Musical Committee in the preliminary work, which resulted in the foundation of the school. It will therefore be seen that a total amount of just £2,000 has been spent on the school by the Society.

XXVI.—GAS ENGINE.

It has often been found that, in order to carry out properly experiments for the illustration of the papers and lectures, some means was required of providing motive power, On frequent occasions the Society has had to borrow a steam engine or a gas engine, and this has generally involved considerable cost, besides placing us under obligations to the firms from whom the engines were borrowed. Under these circumstances, several members of the Council, past and present, undertook to subscribe sufficient to defray the cost of a gas engine, and Messrs. Crossley, the makers of the well-known "Otto" engine, very kindly undertook to let the Society have one of their engines on very favourable terms. The names of the subscribing members are: — Sir Frederick Bramwell, F.R.S., Sir Daniel Cooper, Bart., K.C.M.G,, Mr. Henry Doulton, Mr. Edwin Lawrence, Mr. George Matthey, F.R.S, Mr. W. H. Perkin, F.R,S., and Mr. W. H. Preece, F.R.S.

The engine has been fitted in a cellar in the basement of the Society's house, and will be available for providing the electric light occasionally, or perhaps permanently, and for other purposes, where motive power may be required.

XXVII.—REPAIRS TO PREMISES.

It is now nearly twenty years since very much was done to the decorations of the Meeting Room, and the Council feel that the time has come when a thorough renovation has become needful. Under these circumstances, they have appointed a Committee to go carefully into the matter, and, acting on the report of the Committee, they propose, during the recess, to see that the fittings and decorations of the Great Room and the Library are brought into a proper state of renovation and repair. The Committee are also considering the question of lighting the Meeting Room by means of the electric light, by using the gas engine of which, as above stated, the Society is now possessed, for the purpose.

XXVIII.—JOURNAL.

At the commencement of the present Session certain alterations were made in the manner of printing the *Journal*, which the Council are glad to find have been approved of by the members generally. The Council believe that the alterations produced a considerable improvement in the appearance of the *Journal*, though of course they were not effected without increased cost. In this, as in other matters, the prosperous condition of the finances have enabled the Council to devote a larger portion of the Society's funds than has been the case in previous years; an improvement of this sort had been contemplated for some time, but the finances, until the present year, hardly justified any increased outlay. The current volume of the *Journal* will, it is believed, compare favourably with any of its many predecessors. The value of the *Journal* naturally depends, principally, upon the importance of the papers which are read in each Session, but in addition to these, the Council trust that the varied matter of which the *Journal* is composed contains something of interest for nearly all of the members of the Society, whatever may be their pursuits.

XXIX.—OBITUARY.

Very rarely has it happened that so many losses have been sustained in a single year, as have been borne by the Society during the year now just closed. Many prominent members of its Council, and others who in various ways served the Society, have been removed by death. Some notice has been given of each of them in the columns of the *Journal*. It must suffice now to refer, in very few words, to those who have, since our last report, passed away from amongst us. First among these must be mentioned Sir Henry Cole, than whom no one was ever more closely, or for a longer period, associated with the work of the Society. To him, in no small degree, is due the present prosperous state of the

Society, and his place is one which will certainly never be quite filled up. Another former member of the Society's Council was Lord Hatherley, who was at one time a constant attendant, and was at all times ready to serve the Society in any way. Mr. Scott Russell, who died within the last month, was not only a Vice-President of the Society, but he served as its Secretary from 1845 to 1850. Sir Antonio Brady was, in 1867-68, a member of the Council, and he at all times took a keen interest in much of the Society's work, especially that connected with the reform of the Patent-law. Two gentlemen who have acted as examiners for the Society died during the past year; Mr. Cliffe Leslie, late our examiner in Political Economy, and Mr. Calvert Clapham, who examined in the technology of the alkali manufacture while the Technological Examinations were held by the Society of Arts, and afterwards acted in the same capacity for the City Technical Institute. Mr. Keates and Admiral Nolloth both served on Committees of the Society. Colonel Smith read a valuable paper in the Indian Section, in 1878, on the "Depreciation of Silver," for which he was awarded a Society's Silver Medal. Mr. Dugald Campbell, the well known analytical chemist, was a member of the Society since 1849, and has frequently taken part in the discussions. Mr. W. Newmarch joined the Society in 1866, and on several occasions presided at the meetings.

XXX.—NEW COUNCIL.

There are none of the members of the Council who have rendered more active service to the Society than Professor Abel, Captain Galton, and Mr. Robert Rawlinson, who, with the Duke of Buccleuch and Sir Douglas Forsyth, are the retiring Vice-Presidents. Sir George Birdwood and Sir Philip Cunliffe Owen retire from the list of ordinary members of Council, but their names have been placed on the balloting list for election as Vice-Presidents. The other members of the Council who retire are Colonel Donnelly and Colonel Webber. The loss of both these gentlemen's services will be greatly felt by the Council. As new Vice-Presidents, the Council put forward for election Lord Granville, who has frequently acted in the same capacity before, Sir John Hawkshaw, and Sir Daniel Cooper, the latter of whom also served some years ago upon the Council. As ordinary members of Council there are proposed Mr. Henry Doulton, who has been on before, Mr. Alfred Carpmael, Mr. T. R. Crampton, and Lord Otho Fitzgerald.

XXXI.—LIST OF MEMBERS.

The number of members of the Society still continues to increase. During the year 1881-2, 274 members have been removed from our list by death or resignation. During the same period 375 have been elected. There is, in consequence, an increase of 101. The total number of life members, subscribing members, and Institutions in Union which subscribe to the Society from their own funds is now 3,440.

XXXII.—FINANCE.

The usual Financial Statement for the year ending May 31st, appeared in the *Journal* last week, and from it the members will have been able to form an opinion as to the present financial condition of the Society, and as to the way in which the Council have expended the funds during the past year. Such an inspection will show that the finances of the Society are in a thoroughly sound state. The annual income has increased, as has also the accumulated capital. In every respect the statement points to a most flourishing condition of the Society. It will not, perhaps, be necessary to go in detail through the various items of the account, but some little explanation on a few points may be desirable. Comparing the statement for the past with that for the previous year, ending May, 1881, the first item that will attract attention is the total of receipts for the two years. It will be seen that the receipts for this exceeded those for last year by £1,501. The balance in hand at the commencement of the year was £328 in excess of that of the previous year. The subscriptions and life compositions exceeded those of the former year by £210; and there was a bequest by the late Mr. Edward Bax of £90. Beyond the total of these amounts the difference may be stated to be apparent rather than real, since it was caused by the sale of stock under two heads —first the stock representing the Howard Trust (£528), which it appeared desirable to sell out from the United States 5 per cent. Bonds, and re-invest, and the other stock representing the Memorial Window Fund, the amount of which, as previously stated, has been handed over to the Dean and Chapter of St. Paul's.

On the other side of the account, the charges under the usual heads will be found not to vary very widely from those of last year. The charges for the Domestic Economy Conference

(£316) appear a good deal higher than the corresponding item of last year (£73), but as a matter of fact, the entries in the two statements really refer to the same Conference, most of the charges for which come into this year's account. As a set-off against this, it may be well to call attention to the fact that the Society realised £57 from receipts connected with the Conference. In this year's statement no charges appear under the head of National Training School for Music, the time for which the Society's scholarships were established having, as previously stated, elapsed. The fact that the amount for Committees is higher in the present statement, being £215 against £99, is accounted for by the charges in connection with the preparation of the Society's Patent Bill (£176) being included under this head. The charges for Exhibitions are practically new this year, for the small amount paid in the previous year for the Art Workmanship Exhibition only represents the commencement of the work, the principal charges for which appear in the present statement. The payment to the Dean and Chapter of St. Paul's of the Memorial Window Fund, the re-investment of the Howard Trust and Mr. Bax's legacy, of course appear on the credit as well as on the debtor side. It is gratifying to observe that the amount of the life compositions for the present year exceeds that of last year by £42, being £651, the largest amount received, at all events for many years, under this head. The whole of this sum is permanently invested. Amongst the investments, also, the Council desire to draw special attention to the fact that the Society's finances are in so satisfactory a condition that they have been enabled to repay to capital a sum of £400, part of an amount sold out in 1876, and then applied for current expenses of the Society. This money has been invested in Queensland 4 per cent. Stock. Notwithstanding this investment, the balance at the bankers is very much larger than it was at the corresponding period of last year, being £1,183 against £753.

The liabilities of the Society are practically the same as they were last year, there being only £50 difference, but the assets are very much larger, as naturally results from the investments which have been made during the year. By comparing the present Financial Statement with similar preceding ones, the members will see that the Society's financial position has been very much improved during the past two or three years. This result having been brought about solely by a reduction in the working expenses of the Society, and by restricting the expenditure to what may be considered its legitimate objects, it can only be by similar care in the future that this prosperous state of things can be continued.

The CHAIRMAN, in moving the adoption of the report, referred briefly to the principal points contained in it. He thought that whether the papers read at the ordinary meetings or the lectures of the Cantor series were considered, it must be admitted that the proceedings of the past Session were in every way worthy the Society's high position. As to the Patent Bill, he thought the Society had reason to be proud of having brought forward such a measure, and he regretted that the Government had not seen their way to adopt it, and that it still remained in suspense. In referring to the committee now sitting to consider the question of providing education in forestry in this country, he said he trusted that this would be the means of calling attention to what appeared to be a considerable disgrace to the nation, viz., that young men wanting instruction in forestry had to be sent to France and Germany to receive it, instead of obtaining, at all events, the greater part of their education in this important science at home. Many valuable members have been lost by the Society during the year, and he was sure that all would agree with him that the greatest loss had been suffered by the death of Sir Henry Cole, who for so many years, and up to the latest hours of his life, had devoted himself, heart and soul, to the interests of the Society. In conclusion, he referred to the intended redecoration of the Great Room, and the renovation of the Society's premises generally.

Mr. BOTLY, in seconding the adoption of the report, remarked that he had never known one more satisfactory in every respect. In referring to the obituary, he drew attention to the great loss the Society had suffered in the death of Mr. Scott Russell, whose latest engineering project was for a high level bridge across the Thames below London Bridge.

Mr. CAMPIN said, that in making a few observations on the report, he would naturally be expected to say something about the Patent-law. The Society's Bill was so good a one in many respects that he could not help wishing it were still better. Some points might have been improved, if the committee which prepared it had taken some hints from Mr. Anderson's Bill. What he would propose was that Parliament should have a committee on the whole subject, which should consider Mr. Anderson's Bill with Sir Frederick Bramwell's Bill. In concluding, he said he thought everybody must be satisfied with the general work of the Society.

Mr. LIGGINS referred to the reports in the *Journal* of the discussions which took place in the Society's

Room, and, while praising their accuracy, he regretted that some remarks of his own made at a recent meeting had been misinterpreted in the newspaper press, by which he had been caused much annoyance.

Mr. Martin Wood pointed out the large field of usefulness covered by the Society, and said he looked for valuable results from the labours of the Forestry Committee. He thought action might advantageously be taken by the Council, by carrying on the discussion of some of the other important subjects raised at the meetings.

Mr. Scott Moncrieff expressed regret, as an inventor, at the unfortunate delay which the Society's Patent Bill had suffered. The hopes which had been raised of an improved law had led a great number of inventors to put off the patenting of their inventions, and this evil would continue producing much loss to the commerce of the country, a loss which could not be measured, and would never be known.

The Chairman, alluding to the remarks made by Mr. Campin and Mr. Scott Moncrieff, upon the Society's Patent Bill, said he should be very glad, if called upon, to give evidence at the House af Commons in support of it, and should be glad to receive, himself, any suggestions for its improvement.

The report was then agreed to.

The Chairman declared that the following had been elected to fill the several offices.

The names in *italics* are those of members who have not, during the past year, filled the offices to which they have been elected.

President.

H.R.H. the Prince of Wales, K.G.

Vice-Presidents.

H.R.H. the Duke of Edinburgh, K.G.
H.R.H. Prince Leopold, Duke of Albany, K.G.
Sir Rutherford Alcock, K.C.B.
Sir George Birdwood, M.D., C.S.I.
Sir Frederick Bramwell, F.R.S.
Sir Thomas Brassey, K.C.B., M.P.
Sir Daniel Cooper, Bart., K.C.M.G.
Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E.
Earl Granville, K.G., F.R.S.
Sir John Hawkshaw, F.R.S.
Sir Frederick Leighton, P.R.A.
Sir John Lubbock, Bart., M.P., F.R.S.
Duke of Marlborough, K.G.
W. H. Perkin, F.R.S.
Lord Reay
B. W. Richardson, M.A., M.D., F.R.S.
C. W. Siemens, LL.D., D.C.L., F.R.S.
Earl Spencer, K.G.
William Spottiswoode, LL.D., P.R.S.
Right Hon. James Stansfeld, M.P.
Duke of Sutherland, K.G., F.R.S.
Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L.

Ordinary Members of Council.

Alfred Carpmael.
Andrew Cassels.
Lord Alfred S. Churchill.
Thomas Russell Crampton.
Henry Doulton.
Right Hon. Lord Otho Augustus Fitzgerald.
Edward Frankland, D.C.L., F.R.S.
Admiral Sir Edward A. Inglefield, C.B., F.R.S.
George Matthey, F.R.S.
Admiral Sir Frederick W. E. Nicolson, Bart., C.B.
Loftus Perkins.
W. H. Preece, F.R.S.

Treasurers.

B. Francis Cobb.
Owen Roberts, M.A., F.S.A.

Secretary.

H. Trueman Wood, B.A.

Soane Trustee.

B. W. Richardson, M.A., M.D., F.R.S.

Lord Otho Fitzgerald, in thanking the members for electing him on the Council, assured them he would use his best endeavours to promote the Society's work.

A vote of thanks to the Scrutineers, moved by the Chairman, and seconded by Mr. Cobb, was carried unanimously.

A vote of thanks to the Secretary and the other officers of the Society was moved by the Chairman, seconded by Mr. Andrew Cassels, and carried unanimously.

This vote was acknowledged by the Secretary on behalf of himself and his colleagues.

Lord Alfred Churchill moved that the best thanks of the meeting be given to Sir Frederick Bramwell for his most able conduct in the chair, not only on the present occasion, but during the last two years. According to the bye-laws, Sir Frederick must now retire from the chairmanship, but he did not, fortunately, retire from the Council. The Society had made great advance in the last two years, and the members had very much to thank Sir Frederick Bramwell for, in having devoted so much time and trouble to its interests.

The motion was seconded by Mr. Andrew Cassels, and carried unanimously.

Sir Frederick Bramwell, in reply, said he was very well aware that other Chairmen had been able to give more time to the Society than he, as an engineer actively engaged in his profession, had been able to do. When, however, his colleagues were good enough to nominate him as their Chairman, he felt it would be wrong to accept the post, unless he saw his way to giving a reasonable amount of attention to its duties. It only remained for him to thank the meeting very cordially for giving him the vote of thanks.

The meeting then adjourned.

Miscellaneous.

THE MINT.

The Twelfth Annual Report of the Deputy-Master of the Mint, which has lately been published, contains the following statistics as to the work done at the Royal Mint during the past year. There has been no imperial gold coinage during the year 1881, but the Department was fully occupied till the end of July in maintaining the supply of silver and bronze coin, and executing the smaller colonial coinages required, and during the remainder of the year in providing a large stock of silver coin.

The coins struck during the year 1881 were of twenty-seven different denominations.

The total number of pieces struck at the Mint was 30,351,285, as against 26,870,533 in 1880, and their value, real or nominal, £1,062,969 6s. 2d. The total number of British coins struck during the year was 27,445,132, and their value was as follows:—Silver, £1,004,323 14s. 6d.; bronze, £17,415 15s. 7d.; making a total of £1,021,739 10s. 1d.

The amount of gold coin from the Australian Mints received by the Bank of England during the year, £3,306,000 in sovereigns, exceeded, by nearly a million the amount received in 1880.

SILVER COINAGE.

The amount of silver coin struck during the year considerably exceeded the amount coined in any previous year, except 1872 and 1873, when the demand was excessive. The silver coinages of those years were £1,265,780, and £1,082,424 respectively, as against an average of £577,174 in the seven subsequent years, from 1874 inclusive. The annual average of the whole period of ten years, from 1872 inclusive, has therefore been £739,274.

The number of fourpences in circulation has again been reduced by the withdrawal of pieces of the nominal value of £4,000. It may be assumed, therefore, as mentioned in the last report, that these coins, none of which have been issued since 1856, will soon practically disappear from circulation.

Half-crowns of the nominal value of £229,420 have been issued during the year, and the total amount of these coins placed in circulation since 1874, when their coinage was resumed, has been thus raised to £1,221,490.

In 1880, the new coin sent to colonies amounted to £308,940, and the worn coin withdrawn to £86,425. It will be seen, therefore, that while the home demand for silver coin was considerably in excess of that of 1880, the colonial issues and withdrawals have greatly decreased in amount. This is, no doubt, in some degree owing to the progress made in previous years in the renewal of the silver coinage in colonies, but the issues to the Sydney and Melbourne Mints, and the amounts withdrawn by those branches were nearly as large in 1881 as in 1880, the withdrawals by the Melbourne Mint including, as in 1880, worn coin sent in from other colonies besides Victoria. No new silver coin was sent to the Cape during the year, but since the beginning of 1882, the Government of that colony has resumed its importations, a sum of £28,125 having been issued for shipment to Capetown in the months of January, February, and March.

The average market price at which silver bullion was purchased during the year was $5\frac{13}{16}$d. per ounce, as against $52\frac{1}{8}$d. in 1880, and $52\frac{7}{8}$d. in 1879. It follows that, as the rate at which silver coin is issued by the Mint is 66d. per ounce, the seignorage accruing to the State in 1881 was $14\frac{3}{16}$d. per ounce, or $27\ \frac{1}{3}$ per cent., as against $26\frac{5}{8}$ per cent. in 1880, and $24\frac{13}{16}$ per cent. in 1879.

BRONZE COINAGE.

The bronze coinage executed at the Mint during the year was not large, having only amounted to £17,400, but it was found necessary to make arrangements for the execution of a portion of the coinage by contract. Tenders were, therefore, issued for the supply of 50 tons of pence, halfpence, and farthings, by a private firm, and the tender of Messrs. Ralph Heaton & Sons, of Birmingham, was accepted.

The amount of bronze coin issued during the year was £23,405, bringing the total amount issued, since the first introduction of the bronze coinage in 1860, to £1,498,013.

The general account shows a net profit on the transactions of the Mint, during the year, of £93,822. This account, first compiled in 1872, has, as a rule, shown a profit; but the transactions of the years 1878, 1879, and 1880, owing to the causes explained in the reports for those years, showed an average loss of £29,053. It has been pointed out in former reports that the profit or loss in the operations of the Mint depends almost entirely upon the amount of silver bullion purchased for coinage, and the amount of worn silver withdrawn from circulation, the bullion being coined at a profit, and the worn coin being purchased at its full nominal value, and recoined at a loss.

Respecting the establishment of the Assay Department, which was fixed in 1871, the Deputy-Master writes:—In that year the appointments of the non-resident assayers were discontinued, and a second assayer was added to the staff of the Mint, to perform the duties assigned to them. This change, by which a saving of more than £1,000 a year was effected, was only a return to the system in force before 1851. Under the arrangements which prevailed up to that time, the operations of coining was performed by a company of moneyers, under contract with the Crown, and it was necessary that, in addition to the assayer whose duty it was to protect the interests of the Master of the Mint, and who was styled "Master's Assay Master," there should be an officer independent of the Master of the Mint, styled "Queen's Assay Master," who should be responsible to the Sovereign for the standard fineness of the coin. Since 1851, however, when the contract system was abolished, and the Master of the Mint became solely responsible for the correctness of the coinage, the same reasons have not existed for maintaining two separate assay offices. The Master of the Mint can no longer be brought into conflict with the interests of a body of contractors, and his responsibility to the public is amply secured by the trial of the Pyx, which, under the Coinage Act of 1870, must be held once every year, and constitutes a very severe test of the integrity of the gold and silver coinages.

The number of visitors to the Mint continues to increase, and during the year it was 7,404, as against 6,664 in 1879, and the number of orders of admission issued 1,906.

Mr. Fremantle gives a full statement of the action that has been taken for the reconstruction of the Mint, and the various proposals for its removal to Somerset-house, to the Tower, and to the Thames-embankment at Whitefriars, the final resolution being that the Mint shall remain in its present position, and the buildings be reconstructed.

The report concludes with the following remarks on the condition of the gold coinage :—

"It has for many years been evident that the condition of the gold coinage has been growing more and more unsatisfactory. On the 8th of June, 1842, the Treasury entered into an arrangement with the Bank of England that light gold should be received by the latter on behalf of the Government, and paid for by weight at £3 17s. 10½d. per ounce, the rate at which gold coin is issued from the Mint. A Royal proclamation was at the same time issued, calling attention to the laws and regulations as to light gold coin, and directing revenue officers and others to conform to them. Under this arrangement £11,137,000 of light coin was received at the Mint and re-coined during the 18 months from July, 1842, to February, 1844 ; and so great was the stimulus which appears to have been given to withdrawal that, during the subsequent 14 months to the 31st of March, 1845, a further sum of £3,000,000 in light gold was withdrawn from circulation, although the arrangement with the Government had come to an end, and the Bank of England appears, so early as in January, 1843, to have reverted to its normal practice of paying for light coin at the rate of £3 17s. 6½d. only per ounce. The cost of the whole operation to the State, including the actual expense of re-coinage, was £67,816. The £14,000,000 thus withdrawn was estimated by the Bank of England at the time to represent the whole of the light gold in circulation, except about 5 per cent. The plan adopted in 1842-44, therefore, although it gave rise to much complaint on the part of the public, appears to have been in a great measure successful, but the question has, in 1882, assumed a very different aspect. In 1842, the oldest sovereigns and half-sovereigns had only been about 25 years in circulation, the first issue having taken place in 1817, whereas in 1882 it is necessary to reckon with a coinage which was begun 65 years ago, and which has been permitted during the last 38 years to become lighter and lighter each year. The coins to be withdrawn, therefore, are obviously much lighter, and the loss on their withdrawal would, consequently, be greater than in 1842. Experiments made at the Mint, in November, 1879, on a considerable parcel of light gold, show that the average loss of weight may be taken to be 3d. per £. Taking the gold circulation at £100,000,000, of which about 50 per cent is light, the amount to be re-coined cannot be estimated at less than £50,000,000, and it is also to be noted that the fineness of a large proportion of the coins now in course of withdrawal is deficient, as explained in former reports, to the extent of about £400 per million. It follows that the deficiency of precious metal in the light coin to be withdrawn and re-coined must be reckoned at nearly £650,000, a sum which does not include the expenses of re-coinage."

NEW HYBRID SILK MOTH.

Mr. Alfred Wailly, whose reports on silk-producing and other Bombyces reared by him, have been published in this *Journal*, has submitted to the Council specimens of cocoons and moths of a new silkworm, which he has reared by the crossing of *Attacus (Antheræa) Roylei*, female, the Himalayan oak silkworm, with *Attacus (Antheræa) Pernyi*, male, the North China oak silkworm. The resulting hybrid is larger than either of the parents. Mr. Wailly writes that "the larvæ of the hybrids were reared with the greatest success in France, Germany, Austria, England, Scotland, and United States of North America, and everywhere splendid cocoons were obtained. This year (1882), in April and May, the moths of this hybrid emerged from the cocoons in equal proportions of male and female, all perfect insects, which paired with the greatest facility." He concludes by saying :—"Contrary to what has taken place with the crossing of different species of silk producing Bombyces, I have this time produced a new species, which is larger, stronger, and I think superior in every respect to the parent species, and susceptible of reproduction."

Some notes on these hybrids were read before the Entomological Society on May 3rd, 1882, by Mr. W. F. Kirby.

South Kensington Museum.—On the 22nd of June, 1882, was completed 25 years since the Museum was opened. The number of visitors during the time has been 21,077,654—morning, 14,676,155 ; evening, after 6 p.m., 6,401,499 ; total, 21,077,654.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

RECENT ADVANCES IN PHOTOGRAHY.

By Captain Abney, R.E., F.R.S.

Lecture I.—Delivered January 30th, 1882.

In beginning this course of Cantor Lectures, I make this presumption—that amongst my audience I have those who have commenced photography but recently; also, those who commenced photography about the time I did, say twenty years ago; and that there are very few now who practice those old processes which our forefathers, if I may use the expression, were accustomed to manipulate. I may also say, that I have reason to believe that amongst my audience there are some who know very little of photography at all. I must try and do the best I can to address myself to all. It is a difficult thing; but I hope those to whom I am not exactly fitting my remarks at the time, will remember that I am addressing others, who I also have to consider. I thought, perhaps, it might be useful to go over the very oldest processes with which photography started; and when you recollect that photography is not very old—in fact, is a chicken compared with some of the sciences, and yet that there are very few who can remember its discovery, I think it may be of interest if you see worked out practically before you these very early processes to which I refer.

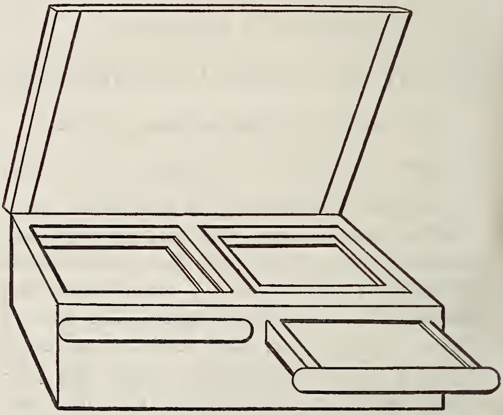
The first germ of photography was when Scheele investigated the action of light on silver chloride, and found that it discoloured it. It was subsequently found that this discolouration of the chloride was due to a liberation of chlorine from the chloride of silver. In 1802, eighty years ago, Wedgwood read a paper before the Royal Institution, in which he described a method of taking profiles, and also copying painted pictures, by means of what we should now call photography. These profiles were taken on paper washed over with silver nitrate. In other words, the profile of the person to be portrayed was thrown against sensitised paper, in a strong light, and the outline was photographed or made visible by the strong light acting outside the profile. Of course it produced a white profile on a black background. About the same time that Wedgwood read this paper, Sir Humphry Davy was practising this process, and he found that silver chloride was preferable to silver nitrate. He also found that if he used white kid as a basis of what I will call the photograph, he got a stronger impression than if he used simply paper. In 1814, twelve years later, Niépce devoted himself to studying the action of light upon asphaltum, and he worked out a process which up to this day is still used, and which I shall not refer to more particularly now, as I shall hope to do so in a subsequent lecture. He developed the process which was then called heliography, which consisted in the production of a picture in bitumen on a metal plate, the light causing the oxidation of the bitumen or asphaltum, and rendering insoluble or less soluble those parts which had been acted upon.

In 1827, Niépce came to England, and endeavoured to introduce the results which he had obtained to the notice of the Royal Society; but, owing to the process being a secret one, the communication was not received.

In 1824, Daguerre, a name to be remembered, a French painter, began similar experiments in the same direction, and, in 1829, he and Niépce entered into partnership to work out that which eventually received the name of photography. Now, Niépce has left it on record, that in his bitumen pictures he had one considerable trouble: he found that, instead of the lines of an engraving being represented by black stains on the white metal, the lines were represented by white metal on black bitumen. In order to overcome this difficulty, after coating the silver plate with his bitumen, and developing it by dissolving away the unaltered parts, he treated the metallic silver plate beneath with any ingredient which he might choose, and amongst others, he has left on record that he treated it with iodine, and then rubbed off the bitumen. This, in the case of an engraving, would of course give dark lines on a white background. Here we have the first introduction of iodine and silver together.

Now, we cannot suppose that two such shrewd observers as Niépce and Daguerre could have used this combination of iodine and silver without noticing that it was altered by light; and I may say that there are a number of grave grounds for considering that this was really the origin of the daguerreotype process, which consists, as you know, in the treatment of a silver plate primarily with iodine, and subsequently with other substances, to cause sensitiveness. Daguerre and Niépce must have noticed the alteration by light in the silver iodide which they had formed on the silver plate, but up to that time of which I am talking, they had not discovered the secret of what we now call development; and when we come to consider the early history of photography, it is a most remarkable fact, that the two first modes of development were discovered, if I may say so, by flukes. The discovery of the development of the daguerrean image was as follows:—He, Daguerre, had been trying to reduce the exposure of iodide of silver, in order to get an image in a reasonable time. Instead of exposing his plate for a quarter of an hour or an hour, he wished to obtain an image in one or two minutes, which, to him, would have been very quick. Many months were passed in these apparently fruitless researches, until one day he placed one of his iodised plates, which he had exposed to light for some short time, in his chemical cupboard. Now, in that chemical cupboard were a variety of bottles of all descriptions. He had worked hard, and as chemists know perfectly well, when a man is working at research, there is usually a collection of all sorts of chemicals. He placed his daguerreotype plate in the cupboard over night, and to his astonishment, next morning, when he opened the cupboard, he found that he had a fully developed daguerrean image. This was a discovery which he immediately turned to account. He exposed other plates, shifting first one bottle then another, and by this process of elimination, at last he was able to find that it was an open bottle of mercury which had caused the development of the image. This was really, I believe, the true history of the daguerreotype process, so far as the mercurial development was concerned. It was considered a very short exposure in those days, if you sat five or ten minutes in the sunlight to have four portraits taken. We have changed all that now, and I dare say before this course of lectures is over, not only five or ten minutes will be considered a long exposure, but perhaps $\frac{}{100}$ths of a second will not be considered short.

I have the pleasure to-night of introducing to your notice, an old worker of the daguerreotype process, Mr. England. He has kindly consented to show the whole manipulation of the process from beginning to end, thinking it might interest what I may call a juvenile audience, for juvenile I suppose most of you are, as regards photography. Mr. England has left me to do the talking, and therefore I must do the best I can to explain the operations which will be gone through. We have a little box, divided into two parts, in one of which is placed iodine, and in the other is placed what is called bromide of lime, that is to say, caustic lime, impregnated with bromine. You will find that, first of all, having polished it, he will place the plate over one of these apertures—over the iodine; the iodine vapour will be allowed to play upon it a certain time, and then he will shift the plate over to the bromine, and thus he bromises the silver. He will finally give it another touch of iodine vapour, and the plate will be ready for exposure. Mr. England has taken the trouble to polish these plates beforehand, since their polishing is one of the chief difficulties of the daguerreotype process. The fact is, the plates require the most elaborate polish, such as even a silversmith can scarcely give them. One of these plates he will now place over the iodine, and for two minutes allow the iodine vapour to rise and attack the silver. [Mr. England here explained that the first process is to bring the plate to a deep yellow



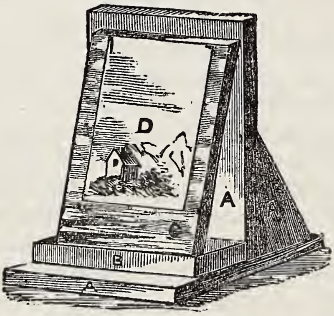
Daguerreotype Developing Box.

colour, by means of the iodine, and then to place it over the bromine.] In the first place, it is necessary to be able to see the colour, so that a reflector is placed on the one side of the sensitising box, the other being open. By this artifice, the plates may be viewed, and the colour of the daguerreotype plate can be watched, till it has attained a deep yellow colour. It is passed on, to be acted on by the bromine, and that is continued until it attains a rose colour. It is a little difficult, by artificial light, to see the exact colour; this process was seldom worked by artificial light, and, therefore, one may be misled by false colour.

We propose, between us, to take a daguerreotype picture. Now, the operation of sensitising is very nearly finished. It has been treated with iodine, and then with bromine, and now it is having a final submission to iodine. The plate Mr. England prepared has now been exposed one minute; Mr. England is rather doubtful about the sensitiveness of the plate, but I am afraid, myself, it is rather over-exposed. Mr. England is now going to develop the picture, and he will do so by the use of mercury. He has here the original mercury box with which he was accustomed to manipulate. He will hang it against the wall, and light a small spirit lamp under a bowl of mercury beneath it. The mercury fumes will rise through an orifice into the box, and so on to a plate; he will watch it from time to time, until it is developed, when we will show it to you. [A copy of an engraving was here taken whilst illuminated by the electric light.]

I should like you to understand exactly what takes place in the daguerreotype plate when it is exposed and developed. On the surface of the plate we have a mixture of silver iodide and bromide, but, for simplicity's sake, I will suppose that there is simply silver iodide on it. When light acts on such a compound, the action is to split up the silver into a salt, which we call silver sub-iodide, and iodine is liberated, $Ag_2 I_2 = Ag_2 I + I$. The iodine is taken up by the silver plate at the back of the sensitive film. To develop the picture, mercury vapour is caused to condense on the sub-iodide, and leave the iodide intact. Amongst some pictures which Mr. England has kindly brought, we have an instantaneous view of New York Harbour, taken about 25 years ago; and I doubt very much whether there are any wet plate instantaneous pictures equal to that; from age it has become a little bit tarnished, but otherwise it is a most perfect picture—the size is about 5 in. by 4 in. I have a transparency taken from this, and one from a negative, also in the possession of Mr. England. This last is a portrait of Daguerre, taken by himself. This is interesting as showing one of the very earliest daguerreotypes known.

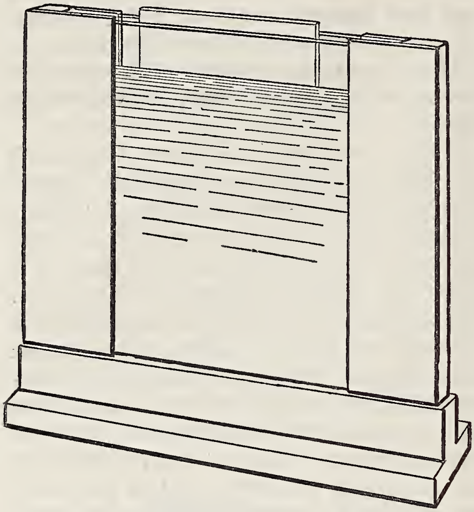
The next process is the Talbotype process. In Talbot's original process, chloride of silver formed the basis, and from that sprung our silver printing process of the present day. But the great improvement he made was by the introduction of iodide of silver. I may mention that he introduced this in January of the same year in which Daguerre introduced the daguerreotype process in France, namely, in 1839. The outline of the talbotype process is as follows:—First of all, he gave a wash of nitrate of silver to plain paper—some papers answered better than others—this he dried, and then washed over it the iodide of potassium, so forming iodide of silver, then dried the paper, and again washed over it the nitrate of silver. Such a paper was found sensitive enough to take camera pictures. But how about the development? Curiously enough, the development of the talbotype picture was discovered in an independent way by the Rev. J. B. Reade. He was practising with the solar microscope, and copying certain objects. One afternoon, having given his paper, which he had washed over with gallic acid, a short exposure, he was obliged to leave it for the night; next morning he found that his image was fully developed. That gave him the idea of the development of what was called the latent image. Talbot introduced this mode of development into the calotype process. This calotype process was the subject of litigation, and the claims of the Rev. J. B. Reade to be the discoverer of the gallic acid development was disputed. I do not wish to enter into the legal question as to who was the discoverer, my own opinion is Mr. Reade should have the credit which belongs to the discovery. From the negative pictures so produced, an unlimited number of portraits would be made by what we call the ordinary silver-printing process. A daguerreotype, on the other hand, could be only reproduced by electrotype, and Mr. England has kindly lent me such a reproduction, which can be examined afterwards. I propose, however, to show you how Talbot was able to make a picture on paper. I intended to have taken a camera picture by the process, with the aid of the electric light, but I find it will take up too much time. I have here a negative with some talbotype paper upon it, prepared as described. I will expose this to the light from a bit of magnesium wire, and then will develop it in the way in which that development was practised in the old time. I have a solution of gallic acid, which I place in a little dish, and with it will mix a solution of nitrate of silver and acetic acid. The acetic acid is meant to retard the action of the gallic acid, to prevent the reduction of the silver before the development takes place. I should say the usual method of using the paper was as follows :—A final wash of gallic acid and silver nitrate was given it, and it was then exposed while damp in the camera. This is what I intended to do, but the minutes steal on us so very rapidly, that I have been obliged to leave out the wash of gallic acid and silver, and to give it a rather longer exposure behind a negative, and thus I shall produce a positive on development. The undeveloped picture is now placed on this piece of glass, and now I proceed to develop it. The glass is placed on a stand, and the light from the lantern, after passing through orange glass, is allowed to illuminate it. The lines begin gradually to appear, and they must now be visible to you all. I continue brushing over the picture the solution of gallic acid and nitrate of silver, with acetic acid, and it becomes still more visible. A paper process is a most fascinating process, because you can dabble about, and do exactly what you like ; it is not like the gelatine plates of the present day, which you have to leave to come out mechanically. With paper, if you want to bring it out a little better detail in one place there, you can dab it out ; and if you want to keep it back, you can put a little water over the place. There is no process like the paper process to please an artist ; not that I profess to be an artist, but, belonging to the Science and Art Department, I have a sort of art instinct, I suppose. I think you can see that the image is very fairly out now. In the old days, I dare say it would be considered passable for a beginner, not that I am a beginner, because I practised it in India ; but it is a long time ago since I did so. So much, then, for the talbotype process. Now, what is the meaning, I would ask you, of that development. It is a curious thing that a small exposure to light should cause an image to appear. I will ask Mr. Woods to throw on the screen something which perhaps will illustrate how development arises. This morning I was in my laboratory, and I saw lying on the bench a feeble negative which I had badly developed, and which I had fixed with hyposulphite of soda. On taking it up, I found the salt had crystallised over the surface in a most beautiful manner, and I do not think I could point out to you anything which would give you a better idea of what development is than those crystals whose images you see on the screen. When you have silver precipitated from a solution by any means whatever, you have it always in a crystalline form, and as all crystals possess polarity, so crystals of silver possess polarity ; and where one silver particle is deposited, there another silver particle will deposit, exactly in the same way as those crystals of hypo-sulphite of soda follow one another in regular course in those beautiful feathers. Thus, then, I look upon it as a physical development ; we have a crystalline action going on during development, and nothing else. The iodide of silver is altered into sub-iodide, and this, like the pole of a magnet, attracts the precipitating silver, and from that time, where the silver is deposited, other crystals of silver are deposited. That is what I call physical development.



Stand for Developing Paper Pictures.

Now, there is another kind of development, which some call chemical development ; and here I differ from some of my brethren who live on the other side of the water, in Germany, who have chosen to name as chemical development something quite different to what my idea is of chemical development. I say chemical development is only a development which is shown by a change in the colour or material of the substance acted upon, and not by a building-up process, such as we have had before us. Now, I have something which I hope will show you what I mean by this chemical development. I have here a picture, which has been printed on nitrate of uranium ; I am going to use simply silver nitrate for a developer. I do not want a reducing agent in the developer in this case, because the uranic salt is reduced to the uranous state by the action of the light, and we shall have a picture formed of silver oxide, because the uranous salt will reduce the nitrate of silver to the state of oxide, and that of itself can be reduced afterwards to the state of metallic silver. This paper was exposed, just before you came to the lecture, to the electric light behind a negative. There is an outline of it now, but when I apply the silver, you will see that it springs out into vividness. It has been rather over-exposed, but this I do not mind, as I merely wish to illustrate a principle. The whole of that picture is formed by silver oxide reduced by the particles of uranium nitrate which have been acted upon by light, and by nothing else. The silver oxide reduced is an exact equivalent of the uranium salt which has been altered by light. That is what I call chemical development, and I know no other meaning for the term. It is impossible, except where you have a change in a large amount of the material that is acted upon by light. I hope I have made you understand the difference between this development and the development you saw just now. The gallic acid, in the one case, reduces the silver solution to the state of metallic silver; and, in the other case, the uranous image itself reduces it to the state of silver oxide; but still that silver oxide was only equivalent to the amount that had been acted upon by light, and nothing more. I have here a wet plate prepared. I dare say most of you know what a wet plate is, though some of you may not if you only began photography when the gelatine process came in. To such, I suppose, a wet plate is as much a matter of novelty as a daguerreotype is to many who know what the collodion process is. I will ask you to bear with me, however, while I produce the picture, because I want to show you the use of the electric light. Of all the recent aids to photography, the electric light is one of the most powerful, because with it you can photograph by night or by day. In fact, in some of the advertisements I have seen it stated that they prefer to take portraits by night; I do not know why, but in a country town I saw an advertisement in which they said distinctly they preferred to take photographs by night, as it was more convenient. [An engraving was focussed on the camera-screen, and the wet plate exposed for twenty seconds.] A short exposure will do for this. Now I will try to show you the development on the screen. You see a cell there with water in it. Now I hope you will see the crystalline action taking place before you, and the image will be seen on the screen gradually coming out. A cell containing ferrous sulphate in solution, and a small quantity of glacial acetic acid, is focussed on the screen. The plate of sensitised (and now exposed) collodion is fairly transparent. After placing a piece of yellow glass in front of the lantern, the plate is immersed in the cell, and the image is seen gradually being built up.

There is another mode of development which our friends across the water have chosen to call chemical development, though I cannot agree with them, and that is the method which is called alkaline development. I dare say I could very rapidly demonstrate that to you. The *rationale* of the alkaline development is that when you have a strongly oxidising agent in the presence of an alkali and a silver compound, solid or in solution, then you have the last reduced to the metallic state. Such an oxidising agent we have in the pyrogallic acid, and the alkali generally used is ammonia. Now, this kind of reduction is evidently useless unless it can discriminate between a compound which has been acted upon by light and one which has not. When pyrogallic acid is used in order to make this discrimination, or, in other words, in order that those parts acted less on by light may alone be reduced, something more has to be added, which is usually a solution of a bromide of an alkali. This restrains the reduction inducing the change to take place in the part acted upon by light. I may say that without a restrainer the tendency is for these parts to be first reduced, but the action extends to that which has not been acted upon by light. It has been usually said that alkaline development is only available for bromide of silver, and until recently I dare say that was the case, or rather it was not the case, but it was thought to be so. I hope on a future occasion to show that iodide of silver is as amenable to alkaline development as bromide of silver, although not so rapidly, and that chloride of silver is very amenable to alkaline development, giving in fact most beautiful pictures. The plate I am going to expose now is a bromo-iodide plate. I have shown you this form of it, simply because it is transparent. I have here a negative, and the sensitive plate behind it, ready prepared. Now I expose it to the light from the magnesium wire for a few seconds. I will take a cell, in which I will place some of the alkaline developing solution. The pyrogallic acid and bromide are mixed, and to which the ammonia is ready for adding. I mix a small portion of this latter with the pyrogallic acid and bromide — the bromide, remember, being for restraining purposes. I place the plate in the cell, which is seen in focus on the screen. The picture is one of Mr. England's beautiful statuary studies, and you can see the outline of the bust gradually appearing. That, I say, is another case of physical development.



Cell for Demonstrating Process of Development.

Now, I want to show you why I say it is physical development. I throw on the screen a slide, which is a picture of a young lady, seemingly cut in half, part of her figure being intense, and part not intense. This difference in intensity was produced by exposing a plate behind a negative, and then before development, coating a portion of the plate with bromide of silver. The top layer thus had no exposure whatever, and yet you see where the unexposed film is, there we have the picture very much denser than in the case where there was only the one film. This shows that here we have a case of physical development, for the image is built up from the film itself, being partly fed, as it were, from the film which had received no exposure. There is thus crystalline action taking place in the film, just as much as there was in the silver reduced from the nitrate of silver. I want you to understand why I object to the words chemical development, when we are talking about alkaline development.

There is another mode of development, which is now very much in vogue, and that is with ferrous oxalate. In this case we have an organic salt of iron in the ferrous state, which is capable of reducing silver bromide, iodide and chloride, to the metallic state, whilst itself is reduced to the ferric state. That was a development which also required a restrainer. If I had had time there were several more experiments I should have gone through, but I must omit them. There is, however, another kindred developer, which I think is one of the most recent advances in photography, about which I am supposed to be lecturing. I speak of it with great tenderness, because it is my own child. I have now got an iron developer, which is capable of being used without any restrainer whatever. I call it ferrous citro-oxalate; it is rather a long name, and some of my audience may not understand it, but I will tell you how it is made. You take a solution of citrate of potash, and then you add ferrous oxalate to it, till no more will dissolve, the resulting compound is, probably citrate of iron, but in a stronger form than is usually found, and much more energetic than that form which was recently recommended by Dr. Eder, to whom I shall have to refer more at length presently. I propose to use some of that same paper which I used just now. Its use for the purpose I have in view is a novelty. This paper can be developed by the alkaline method, or by the ferrous oxalate method, or by the ferrous citro-oxalate method; it is an excellent paper, and was prepared as I described about two years ago at the Photographic Society, before the gelatine papers came into vogue; it gives a very clear picture, and I dare say that you will also see that it gives very satisfactory negatives. I expose a piece of the paper behind a negative to the light of the magnesium wire again. The negative is used in this case was kindly lent me by Mr. William Bedford. It is rather a dense one, and requires longer exposure than I should have given to a thinner negative. The exposure is now given, and on withdrawal from the frame, it apparently is a perfectly blank piece of paper. [The paper was wetted and placed on the developing stand already described, and brushed over with ferrous citro-oxalate without any bromide being added. The lantern was covered with yellow glass, and the light of the disc thrown on the paper.] You see it is beginning to develop; see how beautifully it comes out. This, I say, is a novelty in photography, for here we have an iron developer which needs no restrainer, and a paper which can be developed by an energetic developer.

I think I may claim that as an advance over the calotype process.

I must defer what I have to say on other developers to the next lecture; but before I close, I am gratified to be able to bring before the meeting some very early calotypes, taken by my distinguished friend, Mr. James Glashier, who is President of the Photographic Society, and who has worked at photography from its very earliest beginning. These are some of his beautiful fern impressions he got with the talbotype, and printed afterwards. I will ask the members to look at them, as being early examples, both of talbotype and calotype; the one being developed pictures on iodide of silver, and the other being the printing process of the negative on chloride of silver paper, such as Talbot first introduced. I have also to show you Mr. England's developed daguerreotype. I will undertake to say that under the circumstances it is a very good daguerreotype indeed. Of course a lecture-room is not the place to show all the niceties of the art, and, in fact, it is very difficult to demonstrate before such a large audience, but I hope those experiments which have, luckily, all been successful will at any rate have afforded some instruction to the junior members of the photographic world.

Miscellaneous.

THE MANUFACTURE OF SWISS CHEESE.

The manufacture of cheese in Switzerland, says Consul Adam, of Geneva, is one of the most ancient industries of the country, instruments for this purpose having been found in different parts among the ruins of the lake dwellings. In the 14th and 15th century, the production had grown large enough to become the subject of legislation, as appears from some curious decrees of Berne, Glaris, Appenzell, and other countries, prescribing the form and weight of the cheeses, and forbidding the manufacture of certain sorts, or any exportation to foreign countries. The modern manufacture dates from the introduction 80 or 90 years ago, of the cultivation of artificial fodder, and the system of stabling cattle now universal in the lower valleys and the plains. The several varieties are classified, either according to consistency of material, as "hard," "firm," and "soft," or according to the proportion of fatty matter, as "rich," "medium," or "thin," or according to the coagulation, whether by rennet *(à présure)*, or by sour milk *(à lait aigre)*. The best and most abundant of the Swiss cheeses is the "Emmenthal," a round cheese, 80 to 100 centimetres in diameter, 10 to 15 centimetres thick, and weighing from 50 to 100 kilogrammes, and like all the rich cheeses *(fromages gras)* which retain nearly all the elements of the milk, its nutritive value is high. It was first made in valley of the Emme, in the canton of Berne, whence it followed the Bernese emigration into the neighbouring cantons, where it is now made in large quantities, and into Bavaria, Russia, North Germany, and North and South America. The exportation began, in the last century, to Germany and Italy, and now it is sent everywhere, the principal markets being Germany, Russia, Italy, and the United States. In the winter a large quantity of the "Emmenthal mi-gras" is made mostly for France, where it takes the place of butter. Next in importance is the "Gruyère," called after the village of Fribourg, a cheese about 70 centimetres in diameter, and weighing about 45 kilogrammes. It has come into great repute within the last ten years, since the formation of a wealthy society for its manufacture in Fribourg. It is also made in considerable quanties in Vaud and Neufchatel, and the French provinces of the Jura and the Doubs, where, according to some writers, it originated about 1750. It is manufactured in much the same way as the Emmenthal, except that a third or more of the cream is removed, whence it is classed as "mi-gras," or medium. The exportation is chiefly to France, Italy, and recently to South America. The "Spalen," so-called from the manner of packing for shipment, is a medium cheese, about 50 centimetres in diameter, and weighing 20 kilogrammes, and made in a much ruder manner than the "Emmenthal" and "Gruyère." It comes from Unterwalden, Uri, Schwyz, Lucerne, and the Oberland, and is sent to Italy, where it is used grated with maccaroni, rice, polenta, &c. It comes to perfection in two or three years. Another variety, made for the Italian market, is the "Urseren," which comes from the higher pastures of the valley of that name. It resembles the cheeses of Northern Italy, as does the "Formaggio della paglia," and the "Battelmatt," both produced in the canton of Tessin. The cheese of the canton of Appenzell, long famous for its fine cattle and excellent fodder, differs in certain qualities from all the other Swiss varieties. In making it, the curd is triturated in a brassoir, moulded without pressure or salting, and finally treated with a brine of water, wine, lees of white wine, pepper and salt, which gives it a pungent odour and flavour, something between the Swedish and Italian cheeses. The exact formula for the brine is supposed to be a secret, and, as with most of the Swiss cheeses, the process of manufacture is only to be learned in its own country, where the traditional method has been handed down for generations. The size of this cheese is generally about 30 centimetres in diameter, 15 centimetres thick, and it weighs about 8 kilogrammes. It is exported chiefly to Suabia. A very remarkable cheese also, is the "Schnabziger," or green cheese, and which some writers hesitate to class as a cheese. Its manufacture dates back to the 9th or 10th century, and is considered the most famous product of the canton of Glaris, which turns out a great many varieties. The peculiarity of the "Schnabziger" is due chiefly to the method of coagulation by azi instead of rennet, and partly to treatment by the "zigerlee" *(melilotus cœrulea)*, a plant grown for the purpose in Schwyz. The "Gessenay" is made in the high pastures about the village of that name in Berne, and elsewhere in the Oberland. It is a cream cheese of fine and aromatic flavour, very hard and keeping well for years. Its nutritive qualities are high, and it is largely used, like the "Spalen," grated with soup, maccaroni, &c. A similar cheese is made in the canton of the Valais. This is, perhaps, the richest of all the Swiss varieties, and has a peculiar flavour of its own. The process of manufacture has greatly improved since 1872. Less durable, but equally nutritious and palatable, and of the same general character, is the "Cristallina," made in the valley of Medels Grisons. The "Vacherin" is the only soft cheese of large size made in Switzerland, and there are two kinds, one made near Gruyère, and in appearance resembling the cheese of that name; the other is made in the valleys of the Jura. The latter kind is about 30 centimetres in diameter, 6 centimetres thick, and weighs five kilogrammes. It is sold in drums, and if perfectly mature, has an exquisite flavour. The "Mont d'Or" of France is the same as the "Vacherin" of the Jura. There are many other descriptions of cheese manufactured in Switzerland, among the better know varieties being the "Bellelay," "Prættigau," "Tomme," and the "Blocler."

VINTAGE OF FRANCE, 1881.

Consul Roosevelt, of Bordeaux, states that the details given by the Minister of Finance, in relation to the wine crop, show a considerable improvement. In 1879, 25,000,000 hectolitres (the hectolitre being equivalent to 22 imperial gallons) were produced in France; in 1880, 29,000,000 hectolitres; while in 1881, there were 34,138,715, giving an increase of 9,138,715 over the year 1879. Notwithstanding this improvement, the yield is still 15,000,000 hectolitres below the average of the ten years preceding 1879. In the early part of last year, appearances seemed to indicate the prospect of a very much greater production, but the ravages of the phylloxera, and the abnormal heat which succeeded the constant rains of September and October, to a very great extent blighted the vines. Thus the departments of Charente, Hérault, and Lot-et-Garonne, which, in 1880, produced rather more than in 1879, suffered a greater loss in 1881; for example, Charente showed a decrease of 45 per cent.; Charente Inferieure, 9 per cent., Hérault, 34 per cent., and Lot-et-Garonne, 87 per cent. A number of other districts also showed a marked decrease in their wine production for the last year. The damage done to vines by the phylloxera, is shown by the fact that only 37,000 hectares (the hectare being equivalent to 2·47 acres) of vineyards were reported destroyed in 1880, while more than 100,000 hectares are reported as destroyed in 1881. A partial compensation for this loss is noticed in the fact that in a number of departments where the scourge does not exist to any great extent, there is a marked improvement in both quantity and quality. These departments are Aisne, Aude, Cher, Loir-et-Cher, Loiret, Meurthe et Moselle, Marne, Nièvre, Pyrénées Orientales, Vienne, and the Yonne. As in other years, since the appearance of the phylloxera, the deficit has been made up by importations from Spain and Italy, which supplied about 7,000,000 hectolitres in 1881; 2,320,000 hectolitres were manufactured from dried grapes, and 2,130,000 hectolitres by other artificial processes, which together, make up a total production, in 1881, of 38,590,000 hectolitres. The department of the Gironde shows a falling off of 384,285 hectolitres since 1880, the production that year having been 1,660,235 hectolitres, 1,276,000 in 1881. For the ten years previous to 1879 the average production was 2,793,227 hectolitres.

General Notes.

THE ST. GOTHARD TUNNEL. — The British Consul at Antwerp, in his report on the trade of that port during the past year, points out that the importance of that place, as compared with other ports in the north of Europe, is likely to be increased by the opening of the St. Gothard Tunnel. The distances from several different ports to Milan by the rival railway routes, are given as follows:—Calais to Milan, *viâ* Mont Cenis, 846 miles; Boulogne to Milan, *viâ* Mont Cenis, 819 miles; Ostend to Milan, *viâ* St. Gothard, 786 miles; Antwerp to Milan, *viâ* St. Gothard, 736 miles. Antwerp thus possesses an advantage of 83 miles over Boulogne, and 110 over Calais. The proposed route under the Simplon would, if constructed, still leave Antwerp with an advantage of 38 over Calais, and 10 over Boulogne.

FRENCH AGRICULTURAL SHOWS.—The *Concours Regionaux*, or district agricultural shows of France, under the auspices of the Minister of Agriculture and Commerce, are announced to be held this year as follows:—At Aubenas and at Dax, from 29th April to 8th May; at Avignon and at Châteauroux, from 6th to 15th May; at Nantes from 13th to 22nd May; at Auxerre, from 13th to 22nd May; at Albi, at Niort, and at Draguignan, from 20th to 30th May; at St. Quentin, from 27th May to 5th June; at Saint Lo and at Chaumont, from 3rd to 12th June. In connection with the competition of St. Quentin, the Mayor has organised an industrial exhibition, which has been warmly taken up by the leading manufacturers of the district.

Journal of the Society of Arts.

No. 1,547. Vol. XXX.

FRIDAY, JULY 14, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, 10th inst., at their first meeting, the Council elected C. W. Siemens, D.C.L., LL.D., F.R.S., as Chairman for the ensuing year. The various Committees were also re-appointed.

LABEL FOR PLANTS.

The Council, on the recommendation of the Committee appointed to consider the labels sent in, have awarded the Prize of £5 offered by Mr. G. F. Wilson, F.R.S., for the best label, to E. J. Alment, 124, Romford-road, Stratford, E. The Committee have also commended three other labels, sent by the following:—

George Lang, gardener to I. H. Archer Hind, Coombe Fishacre-house, Newton Abbott.

J. Macdonald, Angeston-gardens, Dursley, Gloucestershire.

P. Neill Fraser, Rockville, Murrayfield, Edinburgh.

The Report of the Committee will be printed in a later *Journal*.

EDUCATION IN FORESTRY.

The following Memorial has been presented by the Council to the Secretary of State for India, in Council:—

To the Most Honourable the Marquis of Hartington, Her Majesty's Secretary of State for India, in Council.

The Memorial of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, sheweth,—

That your memorialists believe that there is a great and growing demand for the services of persons skilled in forest cultivation and analogous occupations, in India and the Colonies generally.

That there is also an increasing desire on the part of land agents, land stewards, and bailiffs to acquaint themselves (at all events to a moderate extent) with the scientific and technical treatment of plantations, woods, and forests, as a means of fitting them for the more satisfactory management of landed estates in the United Kingdom.

That your memorialists believe that no suitable provision exists at any of our great centres of instruction, in this country, for the teaching of natural science in its special reference to forestry, nor for the scientific teaching of sylviculture in any of its branches.

That your memorialists are of opinion that, by a proper adaptation of the subjects taught at some of our large educational establishments to the requirements of the two classes of students already referred to, and by the addition of special means of teaching forest cultivation and cognate subjects, much might be done in the direction of fitting our own countrymen for the management and control of the forests in Great Britain and her dependencies.

That your memorialists are aware that in the absence of any proper provision for giving the requisite instruction in the United Kingdom, the existing system of sending forest students to continental schools of forestry, has been adopted; but your memorialists have satisfied themselves that, by grafting itinerating classes for observation of the practical method adopted in the regularly worked forests abroad on classes for scientific teaching at home, established in connection with such a school as already exists at Cooper's-hill, satisfactory means could be afforded of enabling students to obtain the requisite knowledge, both theoretical and practical, to qualify them for entering upon the duties appertaining to forest management, whether in India, our Colonies, or elsewhere.

Your memorialists, therefore, desire to press this subject upon the attention of your Lordship, and they venture to express their earnest hope that steps may be taken by your Council to establish a department for the teaching of Forestry in the Royal Engineering College at Cooper's-hill.

And your memorialists will ever pray.

Signed on behalf of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, this 28th day of June, 1882,

F. J. Bramwell, Chairman of the Council.
H. Trueman Wood, Secretary of the Society.

Proceedings of the Society.

CANTOR LECTURES.

RECENT ADVANCES IN PHOTOGRAHY.

By Captain Abney, R.E., F.R.S.

Lecture II.—Delivered February 6th, 1882.

At the last lecture I had the honour of giving here, I introduced to your notice the ferrous citro-oxalate developer, for which I claimed the advantage that it was able to work without any restrainer whatever. To-night, I propose to bring before you another developer, which is also able to work without a restrainer; but before I do that, I should like you to take note of an improvement, which has been lately introduced by Mr. Berkeley, in the ordinary alkaline developer. With the pyrogallic acid solution is mixed four times the weight of sulphite of soda. The action, apparently, is this—the sulphite of soda absorbs the oxygen with greater avidity than does the pyrogallic acid, thus leaving the pyrogallic acid free to do its work, and, consequently, we have a developer which remains uncoloured for a very long period indeed. I hold in my hand a bottle which was presented to me by Mr. Berkeley, some time ago, which I read was made up on October 13th, 1881. This contains four times the quantity of sulphite of soda that it does of pyrogallic acid. Here is another bottle of pyrogallic acid, made considerably later—some time in January—and you will see the difference in colour between the two. The one is slightly yellow in tint; the other, a deep muddy brown. I consider that this introduction of sulphite of soda into the developer is one of the most remarkable improvements in alkaline development, and I hope that those practical photographers present will not hesitate to try the formula which Mr. Berkeley has lately published.

I now propose to show you the practical use of the developer to which I referred when I commenced. It is a new one, but has not been used to any very great extent, I am afraid, on account of the high price it used to fetch. I refer to hydro-kinone; the first quantity I bought cost me 12s. a drachm, but, I am happy to say, it is now only 8s. an ounce, and one grain of it goes so far that it is as active as two grains of pyrogallic acid, for it is a much more powerful absorber of oxygen than pyrogallic acid; an advantage with it is, that you are able to use it without any restrainer. You can even develop chloride of silver without adding any soluble alkaline haloid to it, which photographers know is essential when using even a very weak pyrogallic and alkaline development. To illustrate this, I have an opal glass plate which is covered with a film of collodion containing chloride of silver. Until quite recently, this was a film which it was almost impossible to develop by the alkaline or iron methods; but, thanks to Dr. Eder, we are able now to develop chloride of silver exactly in the same way as we can bromide of silver. To save time, I gave the plate a short exposure just before the lecture. In this cell I have now simply hydro-kinone and ammonia, and I think you will see that it developes the plate without the slightest trace of fog. I have taken an opal glass as the background, so that you will be better able to see the result; it comes out very gently and gradually. Thus you see that this new developer works without any restrainer whatever, even when such a troublesome salt as silver chloride is used. Not having any restrainer, it is able to give a better detail, and allow a shorter exposure in the camera than if the ordinary alkaline developer was used. This development is applicable not only for collodio-chloride, but for collodio-bromide plates, or for gelatino-bromide plates—in fact, any plate with which you work, even iodide. [The perfectly developed image was then shown.]

I promised last lecture that I would show you how very easy it was to develop iodide of silver with either the alkaline or the ferrous oxalate developer. You saw in my last lecture how we could develop the iodide with silver and gallic acid, but it becomes a very different thing—at least it was always so considered—when you have to develop a plate containing simply iodide with nothing but an oxalate developer, such as I have here. In this frame I have a paper which is coated with pure iodide of silver, not a particle of bromide or chloride in it; I will give it a slight exposure, and I propose to develop it on the screen before you. I will simply immerse it in water, and use some of the same ferrous citro-oxalate which I introduced to your notice last week. It will be apparent with what facility the iodide of silver can be developed. The paper, where viewed in the yellow light, is apparently colourless, although really it is yellow. If everything be correct, you will see that we get an image developing out rapidly, which is formed of pure metallic silver, reduced from the sub-iodide at first, and then led, as it were, from the adjacent iodide. [The picture was fully developed.] We now have a practical demonstration that you can develop iodide just as easily as you can bromide, which is a desideratum when you come to consider the composition of gelatine plates, with which we may have to deal more fully in subsequent lectures. Having fulfilled my promise with regard to this, the next point I wish to call the attention of the meeting to is the action of sensitisers. I should like to explain to some of you who are not initiated in the mysteries of photography, what a sensitiser is. I will throw a diagram on the screen, and then you will be able to understand better what I mean. When you have chloride of silver, for instance, exposed to light, you have a new compound formed, which is called sub-chloride, or argentous chloride ($Ag_2\ Cl_2 = Ag_2\ Cl + Cl$), and chlorine liberated. This chlorine is a very obstinate thing to eliminate, if you do not give it something that can take it up; for instance, if you place perfectly dry chloride of silver in vacuo, without any trace of organic matter present, you will find, if it is exposed to brilliant sun-light for months, you get no darkening action. If such a white powder was submitted to you, to test by its darkening, you would say at once that it was not chloride of silver, because it was not darkened, since one of the tests of chloride of silver, amongst chemists, is, that it shall darken in the light. Here I have a little bulb of it which was prepared, dried carefully, and sealed up, the vacuum being made by means of a Sprengel pump. This tube has been exposed for months to light, and it is as pure a white as the very first day it was put into the bulb. Another experiment was made at the same time; a bulb was prepared, but in using the Sprengel pump, unfortunately, as I then thought, a small globule of mercury got in the vacuum, and was sealed up with the chloride; the consequence was, that the chloride of silver immediately darkened; although the mercury *was not in contact* with the chloride of silver, the chlorine flew to the mercury, and formed chloride of mercury. This is an instructive experiment, showing that merely in the presence of something that will mop up the chlorine, chloride of silver will darken. Here is another darkened bulb, which is chloride of silver, which was sealed up, not in *vacuo*, but in hydrogen. Now, hydrogen, as you are perfectly aware, can combine with chlorine to form a gas, which we call hydro-chloric acid, so, when the chlorine was in the presence of hydrogen, it combined with it, instead of returning to re-combine with the sub-chloride of silver. On the screen is a diagram showing these reactions of the two other haloid salts of silver. I have already shown you the diagram of silver chloride, and its splitting up by light.

$$Ag_2\ I_2 = Ag_2\ I + I.$$

Silver iodide splits up into silver sub-iodide and iodine.

$$Ag_2\ Br_2 = Ag_2\ Br + Br.$$

Silver bromide, when exposed to light, splits up into silver sub-bromide and bromine.

Now, in order that there shall be a ready darkening of either of these, you must have something which will absorb the iodine or bromine (or in the case of the latter, allow it to escape), whichever you expose to the light. Now, the image which you just now saw developed on the iodide, is, before development, precisely the same as the darkened image on the chloride; it is a matter simply of degree. Of course, if you took a few shot, and hid them in a bushel of flour, you would not be able to know that there was anything black in the flour; in the same way, if you alter two or three particles of iodide into sub-iodide, or chloride into sub-chloride, you do not notice it, because they are so mixed up with the particles that are not altered. It is these little altered particles that are the nuclei for the developed image. In order to show the use of sensitisers, I have prepared a sheet of paper, a quarter of which has been washed over with that vulgar beverage, beer; another quarter with potassium nitrite, and another quarter with gum, the fourth quarter has nothing on it. Now, all these are—but in greater or less degree—absorbents of iodine and bromine, and you will see, when I expose the paper and develop, that there is a decided increase of sensitiveness where those substances have been applied. You may say, "according to what you have said already, that the particles not coated with anything ought not to develop," but you must recollect that we are in contact with air, and air contains moisture, and if you have chlorine, for instance, in the presence of moisture, light is able to split it up into hydrochloric acid and oxygen, so that, in the case of a paper like this, you have a sensitiser present, but only a feeble one. This paper is the bromo-iodide paper that I introduced to your notice some little time ago. I have marked on the different quarters of it what is the sensitiser on each. I will brush it over with this ferrous citro-oxalate developer, and we shall see if there is any difference in the rapidity of coming out. The part coated with nitrite in coming out very rapidly, it has a very inordinate affection for iodine and bromide, the vulgar beverage beer does not seem to be doing its duty as it ought to be; now the gum is flashing out; now the beer is coming. You see the nitrite came out first, then the gum, and then the beer, finally that in which the sensitiser was merely the air and the paper, and you will see, when the picture is finished, there is a vast difference in the amount of development. If there had been no moisture in the atmosphere, if it had been exposed in dry air, there would have been no action whatever where it was not coated with some sensitiser. Here, then, we have a proof that a sensitiser is necessary in order to give the greatest possible sensitiveness, and I hope that this will explain to you what I shall have to allude to further on.

I next have to call into use the spectrum. Here we have it on the screen, and I have produced it by the same arrangement of apparatus as if I were going to use it for photography. You will see that we have a tolerably clear spectrum. We have the light, A, and a lens, L, to throw the image on the slit B, and then the lens, C, to make the rays parallel, then a single prism, D, then a photographic lens, E, which focusses the spectrum on the screens. Now I want to point out to you not only that we have red, green, yellow, blue and violet rays, but we have rays beyond the violet also which we cannot see, but which by an artifice I shall be able to show you. For instance, if I place this card on this screen, you see we have a vast extension of the spectrum beyond the violet, but if I take it away, it is absent. The reason of that is, that I have brushed on this card a solution of sulphate of quinine, which lowers the wave light of the ultra-violet rays, making them visible. I was anxious to bring this spectrum before you, for this reason, that it is the principal part of the spectrum which is useful to photographers, though I do not believe they are aware of it. When we expose one of these haloid salts of silver to the spectrum, it behoves us to know what part of the components of light it is that acts upon this haloid salt. Now, a very simple way is, of course, to place a film containing the haloid salt in the spectrum. But what I want first to point out to you is, that we must go upon scientific principles in dealing with the facts that come before us, and the main principle is the principle of work. When you have what you call light radiating from a source, be it the sun or be it a gas flame, it is only when its radiant energy is stopped or absorbed that you are able to get any work out of it all; that is to say, supposing you have a transparent glass plate, you know that the light, as you call it, passes straight through the plate, without leaving a very visible effect on the glass. But if you have a red glass, why does it appear red? Simply because a part of the rays have been stopped; but what becomes of those rays that are stopped? they must take one of two forms, or rather, the work they do must take one of two forms. The work they can perform may be shown by the heating the glass, or else the energy must be exhausted by doing chemical work upon the substance on which it acts. The effect then, is this, if you have an haloid salt of silver, the principal part of the energy which is radiated, and which is absorbed, does chemical work, and it is only those regions of the spectrum which are absorbed which are capable of doing chemical work. I cannot show you a better example than I have upon the screen. The second part of the slide shows the whole spectrum, taken with a substance which I shall be able to show you by-and-bye. You see the darkening caused by the light; at the far end we have the ultra-violet rays, and at the other end we have the red rays. In front of the slit of the spectroscope was placed a cell of bichromate of potash, and you see it cuts off, not only the blue and the violet, but a part of the green, and leaves the red and yellow intact (B, Fig. 2).

FIG. 1.

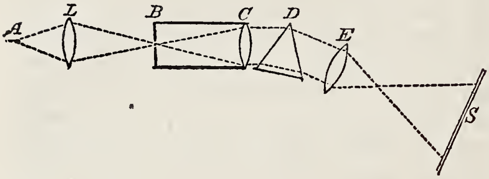
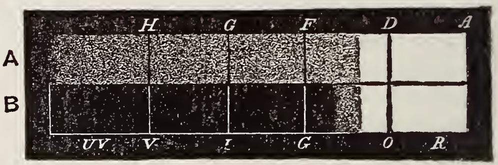


FIG. 2.



Now, photographers know that those beautiful prints that go by the name of carbon prints depend for their manufacture on the fact that bichromate of potash is altered by light in the presence of organic matter. Here we have the spectrum taken on carbon tissue, in which you will see the absorption exercised by bichromate of potash exactly coincides with the work done on the bichromate (A, Fig. 2); notice that the part of the spectrum which is impressed ends exactly where the bichromate absorption begins. I think that is a very excellent illustration of the work done by radiation. I propose now to pass two or three films through the spectrum

(I., Fig. 3), to see what kind of work we may expect to be done with them. First, we have a film of chloride of silver (II.), and you will see that the violet part of the spectrum towards the yellow is subdued, whilst the other parts pass through. Next, we have a bromide film (III.) in which you see some parts of the spectrum are cut off which before were visible. Next, I take iodide (IV.) where you see the violet is cut off entirely, leaving a trace of blue, which was not the case with the bromide. Here, again, we have the bromo-iodide (V.) cutting out the blue, going right into the green. That is interesting, because I propose to show you next the fact that the absorption coincides with the work done on the films themselves.

FIG. 3.

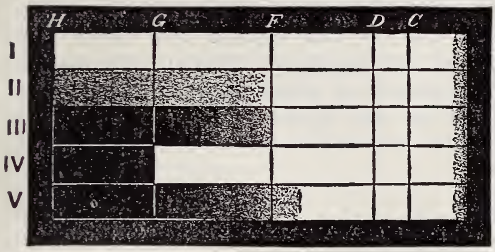
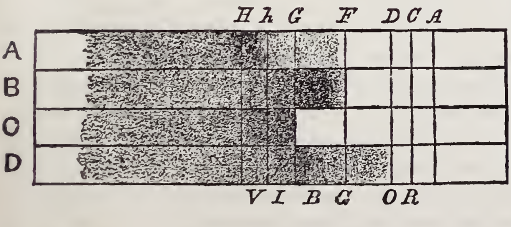


FIG. 4.



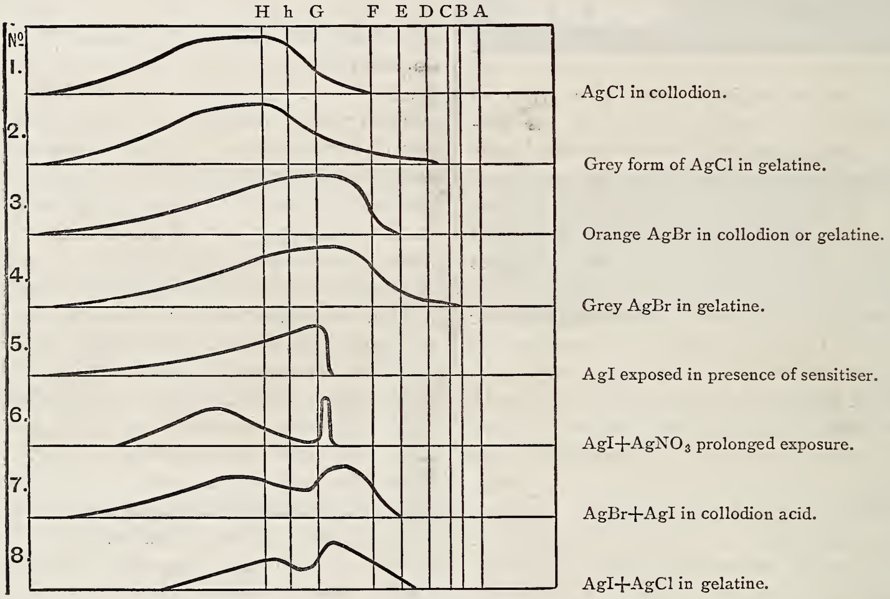
I have here a board with four strips of paper upon it. The first coated with chloride of silver, the second with bromide of silver, the third with iodide of silver, and the fourth with bromo-iodide of silver. I will expose each of them for twenty seconds, to the spectrum, and develop them before you. In order to recognise the parts acted upon, there are strings put across the different parts of the spectrum. [The exposures were made, and the strips damped and placed on the developing board.] I brush each strip over with the ferrous-citro-oxalate developer. [The prints developed rapidly, the chloride taking rather longer than the others to appear.] The chloride sometimes takes a little longer to develop, and I ought to have given it a little longer exposure, because it is not quite so sensitive as the other salts. Here are the four spectra (Fig. 4). The maximum sensitiveness of the chloride, A, is about the line H on the spectrum. The iodide, C, goes as far as G; the bromide, B, half-way between G and F, and extends down as far as B; the bromo-iodide, D, extends as far as F in the spectrum. I think I can show you this more directly by photographs taken in the spectrum, in a more accurate manner than is possible in a lecture experiment. When I passed the different silvers over the spectrum, I only passed the haloid salts in the state in which they are usually prepared photographically, but now I wish to show you how different coloured salts of silver can be obtained. Let me take bromide, for instance. Here you have the ordinary form of bromide, such as you saw developed on the screen—the red or orange bromide. By boiling it, as you do, with gelatine emulsion, you can change the molecular condition into a gray blue form, such as you see here. From what I have told you of the principle of work and absorption, you will be quite prepared to learn that these particular forms are sensitive to different parts of the spectrum; so they are, but their maximum place of sensitiveness is but very slightly changed; that is a point worthy of attention. Again, we have two forms of chloride, the ordinary form, which, as a rule, is decidedly yellow by transmitted light; and the other is the blue molecular form, which is got by boiling. Once more, we have the iodide in the yellow form, and also the blue form. Now, I will show you photographs which were taken to show the maximum of the different haliod salts (Fig. 5, p. 884). The first one is the red form of chloride (No. 1), and you see that the maximum sensitiveness is half-way between H and *h* in the violet part of the spectrum; if we go to the boiled chloride (No. 2) you see it has the same place of maximum intensity as the orange, and that the intensity is very great as far down as the yellow line, D. We next come to the red form of bromide (No. 3), and we see that its maximum place of sensitiveness is half-way between G and F. When we come to the blue form (No. 4) we have an immense extension towards the red, but still it retains nearly the same place of maximum sensitiveness between G and F. Next, we have the yellow form of iodide (No. 5), and it shows that it ends sharply at G. There is no spectrum impressed beyond G. In one case where I gave it a very prolonged exposure, I got what is called a reversal of the image, but still the iodide spectrum is cut off at that particular point (No. 6).

The next spectra are exceedingly interesting, to me at all events, and I should like them to interest you. They represent a new form of molecule. I believe very few people know anything about them. The peculiarities of the mixture were discovered by me, and a paper about them sent to the Royal Society a very short time ago. That molecule is this: it is not a combination between iodide and bromide in the ordinary acceptation of the word, that is to say, it is not $Ag_2 Br_2 + Ag_2 I_2$, or not simply one equivalent of each of bromide and iodide of silver added together, but an absolute combination, $Ag_2 Br I$, or a double molecule, which has been formed, and on which the spectrum has a totally different effect. You will see (No. 7) that, instead of having the maximum intensity at G, its maximum is far into the green, and it has a minimum about G. In the same way another molecule is formed by a combination of molecules of chloride of silver and iodide of silver, and that, too (No. 8), has no maximum about G, but has a minimum there, which is the place where the maximum sensitiveness is found in the ordinary iodide of silver.

I will try and explain how these last curves are produced; if you take iodide and bromide of silver together, and expose them to the spectrum, what happens is this; first of all iodine and bromine are liberated. What becomes of the iodine and bromine? The bromine immediately attacks the sub-iodide of silver, and forms a new molecule, $Ag_2 Br I$; the bromine undoes the work of the iodide as fast as it is done, so that we have, in the place of maximum intensity of the iodide, the least work done. In the same way with the chloride. The chlorine liberated from the chloride undoes the work which is done by the iodine; the consequence is that, in the place of maximum intensity of the iodide, we have a diminution of intensity in the case of the double salt; in other words, the dry bromo-iodide of silver is less sensitive for the spectrum about the part G than any other part of the spectrum to which it is sensitive. In order to prove that, I will tell you a little experiment which was carried on by myself. Chloride of silver was absolutely blackened in the light, and sub-chloride was formed; then it was treated with iodine again, and it become a buff colour. When this new molecular form was placed in the spectrum, we got exactly the same result as we do here, showing that we have a new molecule of chloro-iodide of silver. I think this will very likely throw a great deal of light upon some of the phenomena which are met with in ordinary dry-plate work.

Now, I crave your attention to one thing. You may ask if chlorine always undoes the work done on the iodide. The fact is, that it

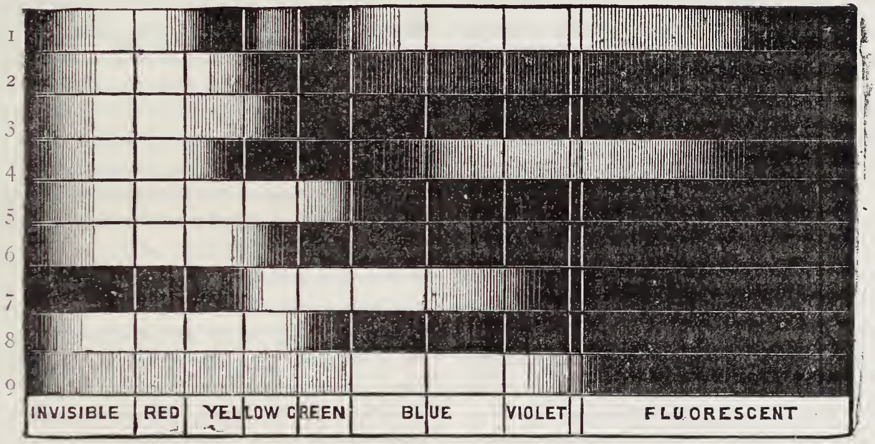
FIG. 5.



does not, if you have free nitrate of silver present; since this salt is able to take up the iodine and bromine, therefore the bromine cannot act on the sub-iodide of silver; it leaves it there, and you have the impressed spectrum totally different; in fact, the bromide and iodide spectrum are superposed one on the other. There are a great many facts I could show you to prove this. We come to the conclusion then, for sensitiveness, you must have a sensitiser present. In gelatine plates, you may say that gelatine is a sensitiser, but it certainly is a very feeble one; anyhow, if you want to get sensitiveness in a plate, you must have a sensitiser present which will mop up, not only iodine, but bromine. When this is the case, bromine cannot go and destroy the work done on the iodide.

Before concluding this part of my lecture, I may also say I that have found that the printed image and the developed image have precisely the same characteristics. Thus, if you get pure iodide of silver, you get the termination of both the printed and developed spectrum close to G. A curious thing with regard to iodide is this, if you have the smallest trace of impurity in it, it is immediately shown in the spectrum by a prolongation below G, and you can go to the chemist and tax him with having given you iodide which is not pure.

FIG. 6.



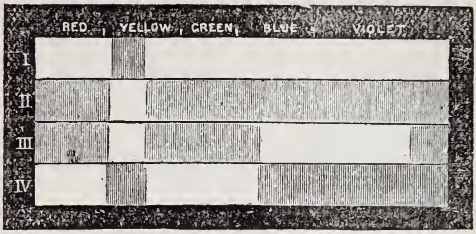
1. Cobalt glass.
2. Ruby glass.
3. Chrysoidine.
4. Magenta.
5. Flashed orange.
6. Stained red glass.
7. Bottle green.
8. Aurine.
9. Quinine.

Now there is one point that has exercised the minds of a great many photographers, and that is the illumination of their dark rooms; and I hope I may be excused if I go over what may be apparently well trodden ground, but I believe that there are many here present who have no absolute certainty as to why they are using certain glasses to glaze their developing rooms. I want to show photographers the absolutely safest light they can use in developing their pictures. Here we have a spectrum, and beyond it you see the fluorescent rays. I will ask Mr. Woods to pass through the spectrum one or two glasses. First of all, we will take ruby glass (No. 2), and you will see that when it becomes very bright indeed, there is a certain amount of blue light comes through the glass; I can see a trace of yellow, and a trace of green. Now I will take the yellow glass; here is one which photographers are very fond of, but I dare say you will see that there is a great deal of blue light comes through that. That was the ordinary glass used for photographic dark rooms, within the last half dozen years, and people were perfectly content if they glazed their rooms with it. But there are yellows and yellows, and I will show you the difference between two. Now we will have a magenta (No. 4), which you see cuts off a great deal more light. The next (No. 6) is a stained red glass, which cuts off the green too. Now there is one combination which I wish to show you, because people often complain that their photographic studios are not safe as to light, and that they use ruby glass and get foggy plates. I have great doubt about fogging bromide plates with proper red glass, where ordinary precautions are taken, though not with the ruby glass which lets blue light through. If people would only use the spectroscope with a strong light, they would very soon see where their glazing is at fault. Now, I will throw on the screen the light through a piece of blue glass (No. 1), and I think you will see that there are bands in the red and yellow; there is plenty of blue coming through and some green. Now, I will ask Mr. Woods to give us a combination of stained red and blue; you see a red line and nothing else. If photographers want to be absolutely safe, let them glaze their studios with cobalt glass and stained red, and they will get nothing but the light of that particular refrangibility, which I will warrant is totally unable to affect any gelatine plate, of the ordinary type, at all events. You may glaze and glaze with ruby, but you will never get rid of blue light entirely. Of course it diminishes with every thickness you take. If you want to use ordinary plates, which are not so sensitive that you cannot look at them, my advice is to use a combination of stained red (No. 6), and ruby glass (No. 2), which will give you a comfortable light to work in, for it cuts off the blue, and leaves the red in a brilliant patch. Those that are using that combination ought to have nothing to fear; but if they still fear, let them use a combination of cobalt (No. 1) glass and stained red glass (No. 6), and then they will only get the colour of that narrow strip of light which you saw just now. I should like to show you the green glass in the spectrum (No. 7), that you may judge what kind of light gets into it. It was at one time seriously recommended as an admirable thing for not trying the eyes, and for being safe to use in the developing room. A combination of red and green is a fairly safe light for iodide plates or ordinary plates, but not for gelatine plates, which are extremely sensitive. Next we come to a series of pretty colours, which may be very useful to us. Here is the spectrum of magenta (No. 4); the yellow is cut out entirely, and the green, leaving the blue, violet, and orange. Now I will try aurine (No. 8) and chysoidine (No. 3). Here you see the blue is gone entirely. Some have said that the ultra violet rays go through aurine, but I will leave it to you to say whether they do or not. There is no trace here of the ultra violet rays when I apply this card with the sulphate of quinine on it. They should appear if there were any. We have next a combination of magenta and aurine, which is a perfect red light, and is very good indeed for the photographic studio. I think I may say, without a breach of confidence, that I believe a certain "ruby medium" in the market is made according to the directions that I gave some time ago. You may ring the changes of combinations of these glasses; you may have scarlet and aurine, or magenta and aurine, and either one or the other will give you this red band only. If all other means fail, the photographer may use the ferrous oxalate developer. You will see that it cuts off the blue light at all events. I should not at all mind developing a plate in such a light as that. In fact, you may bring the most sensitive plate out into a white light, when developing in a dish, with a covering of ferrous oxalate over it. I hope that, having seen these spectra, you will lay to your heart what I have been saying to you about the glazing of your dark rooms. I thought this was a subject that I ought not to pass over without some reference.

In 1874, we had a most astonishing discovery made, and that was, that by dyeing a film of sensitive collodion you were able to get an increased action by the spectrum. In common with others I took up that subject and investigated it, and I wish to draw your attention very briefly to it to-night, because I think it is one of the advances made in photography which ought not to be passed over. If you take one of these aniline dyes, such as a blue dye, and expose it to light behind a piece of black paper, with an aperture in it, such as I have here, you get an image on the dye, such as you see. What is the meaning of that? The meaning is that the dye is oxidised, for if you apply an oxidising agent you get the same result. Dr. Vogel found that if you dyed plates with some of these fugitive dyes—they were all fugitive to a great extent which he used—he was able to obtain an extension of the impressed spectrum exactly in those parts of which the dyes absorbed, and he introduced the term optical sensitiser to describe the fact. Now, I am going to quarrel with that expression, because he explains it in this way; he says, in effect, that the sensitive aniline dye is able to take up a vibration, and to direct it to something else; in other words, that when light has done all it can in endeavouring to bleach a dye, that its period is transformed, and it does something else on the silver salt which is in contact with it. Well, that is not a philosophical way of looking at things, because if you could only arrive at that principle, you might just as easily arrive at the principle of perpetual motion, which is a thing which I am not prepared to admit. Now, I honestly say, that for a long time these experiments staggered me, and the arguments Dr. Vogel brought forward seemed fully to justify his term of optical sensitiser, as applied to the dye stuff, but eventually I was able to come to a different conclusion, and that conclusion I wish to put before you. If you have a substance which is oxidised in the presence of an haloid salt of silver, what do you expect? You expect that the haloid salt of silver would be reduced. If you place pyrogallic acid in contact with the haloid salt of silver, and help it to be oxidised by ammonia, you expect that the haloid salt of silver will be reduced, and I lay the action of the dye to precisely the same principle as the pyrogallic acid, which helps to develop the image; in other words, the oxidation of the dye causes a reduction of the bromide of silver, or iodide of silver, as the case may be, and simply provides a nucleus on which development can take place. I wish, however, to point out that Dr. Vogel has an objection to my explanation. He says, "Oh, but you require time to bleach things, you require time to alter them." So you do; you require time to blacken the chloride of silver, nevertheless, the slightest exposure to light begins the change in it, and so the slightest exposure to light begins the change in the dye, and on this principle, of course, the action of dyes upon sensitive films can readily be explained.

I have got behind the screen three pieces of sensitive bromide paper, one dyed with a blue dye, and another with eosine, the third, pure bromide of silver without anything. I propose to develope those on the screen. I must give this rather a longer exposure than last time, because blue dye takes away the sensitiveness to a material extent. You can see the colour, it is somewhat of a lavender grey, which no doubt will show that it absorbs exactly in the same position where the extra length of the spectrum is developed. In the eosine, I dare say you notice a peculiar dimming of light about the green; this is a very fluorescent dye, and it is in that position where we shall expect the action to take place. I will, however, show you where the absorption takes place of these two dyes we have used. This is a spectrum of the dye, it lets the ultra-violet rays through; in the green we have a great cutting off. Here we have the cyanine, which is a different colour altogether. It cuts off the yellow, and also the green; therefore, on the principle of work, we should expect that where absorption takes place in the dye, there dye would be oxidised, and the silver reduced in consequence. I now expose the three slips of paper above alluded to, and I will develop them before you. [The papers were developed in yellow light, as before.] The impression of the spectrum on the eosine dyed paper flashes out, the part in the green comes out very strongly indeed. The blue dyed paper shows, besides the ordinary spectrum of the bromide, a band in the yellow. Finally, we have the undyed paper. The above diagram shows the effect obtained on cyanine blue. Here you see the marked difference in the three cases.

Fig. 7.



Miscellaneous.

FIRE-RISKS OF THE ELECTRIC LIGHT.

The Committee of the Society of Telegraph Engineers and of Electricians, appointed on May 11, 1882, to consider the subject of Fire-risks arising from Electric Lighting, have formulated the following rules and regulations for the prevention of these risks:—

These rules and regulations are drawn up, not only for the guidance and instruction of those who have electric lighting apparatus installed on their premises, but for the reduction to a minimum of those risks of fire which are inherent to every system of artificial illumination.

The chief dangers of every new application of electricity arise mainly from ignorance and inexperience on the part of those who supply and fit up the requisite plant.

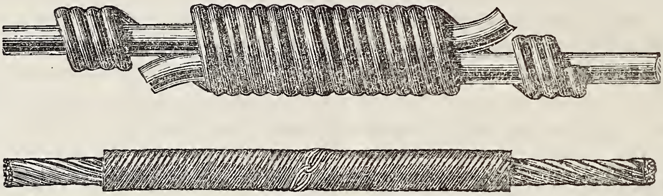
The difficulties that beset the electric engineer are chiefly internal and invisible, and they can only be effectually guarded against by "testing" or probing with electric currents. They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the production of heat. These defects can only be detected by measuring, by means of special apparatus, the currents that are either ordinarily or for the purpose of testing, passed through the circuit. Bare or exposed conductors should always be within visual inspection, since the accidental falling on to, or the thoughtless placing of other conducting bodies upon such conductors might lead to "short circuiting," or the sudden generation of heat due to a powerful current of electricity in conductors too small to carry it.

It cannot be too strongly urged that amongst the chief enemies to be guarded against are the presence of moisture and the use of "earth" as part of the circuit. Moisture leads to loss of current and to the destruction of the conductor by electrolytic corrosion, and the injudicious use of "earth" as a part of the circuit tends to magnify every other source of difficulty and danger.

The chief element of safety is the employment of skilled and experienced electricians to supervise the work.

I.—The Dynamo Machine.

1. The dynamo machine should be fixed in a dry place.



2. It should not be exposed to dust or flyings.

3. It should be kept perfectly clean, and its bearings well oiled.

4. The insulation of its coils and conductors should be perfect.

5. It is better, when practicable, to fix it on an insulating bed.

6. All conductors in the dynamo-room should be firmly supported, well insulated, conveniently arranged for inspection, and marked or numbered.

II.—The Wires.

7. Every switch or commutator used for turning the current on or off should be constructed so that when it is moved and left to itself, it cannot permit of a permanent arc, or of heating, and its stand should be made of slate, stoneware, or some other incombustible substance.

8. There should be in connection with the main circuit a safety fuse, constructed of easily fusible metal which would be melted if the current attain any undue magnitude, and would thus cause the circuit to be broken.

9. Every part of the circuit should be so determined, that the gauge of wire to be used is properly proportioned to the currents it will have to carry, and changes of circuit, from a larger to a smaller conductor, should be sufficiently protected with suitable safety fuses, so that no portion of the conductor should ever be allowed to attain a temperature exceeding 150° F.

N.B.—These fuses are the very essence of safety. They should always be enclosed in incombustible cases. Even if wires became perceptibly warmed by the ordinary current, it is a proof that they are too small for the work they have to do, and that they ought to be replaced by larger wires.

10. Under ordinary circumstances, complete metallic circuits should be used, and the employment of gas or water-pipes as conductors for the purpose of completing the circuit should in no case be allowed.

11. Where bare wire out of doors rests on insulating supports, it should be coated with insulating material, such as india-rubber tape or tube, for at least two feet on each side of the support.

12. Bare wires passing over the tops of houses should never be less than seven feet clear of any part of the roof, and they should invariably be high enough, when crossing thoroughfares, to allow fire-escapes to pass under them.

13. It is most essential that the joints should be electrically and mechanically perfect. One of the best joints is that shown in the annexed sketches The joint is whipped around with small wire, and the whole mechanically united by solder.

14. The position of wires when under ground should be laid down so as to be easily inspected and repaired.

15. All wires used for indoor purposes should be efficiently insulated.

16. When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses like iron girders or pipes, they should be thoroughly protected from abrasion with each other or with the metallic masses, by suitable additional covering; and where they are liable to abrasion from any cause, or to the depredations of rats or mice, they should be efficiently encased in some hard material.

17. Where wires are put out of sight, as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.

N.B.—The value of frequently testing the wires cannot be too strongly urged. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering, by electric action.

III.—Lamps.

18. Arc lamps should always be guarded by proper lanterns to prevent danger from falling incandescent pieces of carbon, and from ascending sparks. Their globes should be protected with wire netting.

19. The lanterns and all parts which are to be handled should be insulated from the circuit.

IV.—Danger to Person.

20. To secure persons from danger inside buildings, it is essential so to arrange the conductors and fittings, that no one can be exposed to the shocks of alternating currents exceeding 60 volts; and that there should never be a difference of potential of more than 200 volts between any two points in the same room.

21. If the difference of potential within any house exceeds 200 volts, whether the source of electricity be external or internal, the house should be provided outside with a "switch," so arranged that the supply of electricity can be at once cut off.

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FRIDAY, JULY 21, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1882.

The list of successful Candidates in the Examinations for the present year has been printed, and is forwarded to the Institutions in Union with the present number of the *Journal*. Copies will also be sent to the various Local Boards for the successful candidates.

"*OWEN JONES*" *PRIZES*, 1882.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers, and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal.

The following is a list of the successful candidates:—

1. Thomes E. Doran, School of Art, Macclesfield, design for Silk Hangings.
2. James Meine, School of Art, Kidderminster, design for an Axminster Carpet.
3. Thomas Linnell, School of Art, Leicester, design for Tapestry Hangings.
4. Alexander Park, School of Art, Glasgow, design for a Carpet.
5. John Sykes, School of Art, Leicester, design for a Wall Paper.
6. Frank E. Adams, School of Art, Macclesfield, design for Furniture Silk.

REPORT OF THE PLANT LABELS' COMMITTEE.

As was the case last year, a considerable number of labels were exhibited in competition for the medal and prize, some marked by considerable ingenuity, others again showing ignorance of what labels are exposed to in open borders, rockwork, &c.

The Committee considered the label of E. J. Alment, 194, Romford-road, Stratford, E., to be meritorious, and to have decided novelty in its construction, they were therefore able to award the prize to it.

They commended the label bearing the motto "Stans pede in Uno," George Lang, gardener to J. H. Archer Hind, Esq., Coombe Fishacre-house, Newton Abbott, as having some originality, as being useful for some purposes, and not expensive.

They commended "The Angeston Label," J. Macdonald, Angeston-gardens, Dursley, Gloucestershire, as having merit, and suggest the stem being made longer, and the label upright.

They considered the label marked "F," P. Neill Fraser, Rockville, Murrayfield, Edinburgh, the best metal label for rockwork and general purposes, where large labels are not required; it has not, however, sufficient novelty to justify the prize being awarded to it.

The Committee's last year's report concludes with these words:—"Wood is probably the cheapest and best material for cheap labels. It is at present liable to the objections that the part in the ground rots, and the writing becomes illegible. If by some process, such as perfect kyanizing or treatment with paraffin, these objections could be removed, an excellent cheap label would be the result. Such labels, however, would have to be tested in actual use against unprepared labels, before any award upon them could be made." Experiments have been made in this direction with encouraging results; wooden labels placed in a cool orchid-house, which when unprepared became sufficiently mouldy to make the writing illegible, when prepared by being steeped for 12 hours in hot paraffin (the white solid paraffin), have remained unchanged after exposure for a considerable time. It seems, therefore, probable if this process be carried on further, and wooden labels be thoroughly saturated, that we may obtain what is still a desideratum, especially for amateur gardeners, a rough and ready label to be used when potting a number of plants, with hort time to do it in; a label which will last and continue legible for at least five years.

Mr. G. F. Wilson, F.R.S., has renewed his offer of a prize, which offer the Council have accepted for next year. Particulars will be issued later on.

Proceedings of the Society.

CANTOR LECTURES.

RECENT ADVANCES IN PHOTOGRAHY.

By Captain Abney, R.E., F.R.S.

[*The right of reproducing these Lectures is reserved.*]

Lecture III.—Delivered February 13th, 1882.

I finished my last lecture by showing you the effect that dyes had upon sensitive salts. In my previous lectures I have not touched on the method of producing sensitive surfaces, except by the calotype or paper process, or by the wet collodion process; but I should be remiss if I did not mention the subject of collodion emulsions, which have been in vogue now for seven or eight years, but which have been supplanted, to a large extent, by gelatine emulsions. Whether that be an improvement upon the collodion process, except for certain things, I hesitate to say; but certainly, in a collodion emulsion process, we have a process which is admirably adapted, at all events, for landscape work. The collodion emulsion was originated, I believe, in September, 1864, by Messrs. Bolton and Sayce, and a new era was opened out when they made their first emulsion.

Now, an emulsion is very simply formed, particularly a silver bromide or chloride emulsion; but, as far as I know, it has been rather a crux amongst photographers to make an emulsion with silver iodide. However, this is a very easy thing to do, and I propose roughly to show those who are initiated in emulsion-making how an emulsion can be made, and further, how iodide of silver can be made amenable to treatment. The point in emulsion making seems to be, to get the precipitate in as fine particles as possible, and it is said that this can only be obtained, except at very great cost of time and trouble, by first adding the soluble bromide, or iodide, to the collodion. If you take the trouble to add the silver to the collodion, first of all, the aspect of emulsion making is entirely changed, and you can get any amount of fineness by adding the iodide or bromide to the silver contained in the collodion so long as you keep the silver nitrate in excess. In this bottle is some ether, and some gun cotton which is not dissolved up. In this test tube I have some nitrate of silver dissolved in alcohol containing a very little water. I simply pour this solution into the mixture of ether and gun cotton, shake it, and I find an *emulsion* of nitrate of silver in collodion, since the alcohol and ether dissolve up the cotton. In the old days, emulsion makers would have said there is something wrong in having an emulsion of silver nitrate, but I think I shall soon demonstrate to you that in reality it is all right. Now I will add an iodide to this silvered collodion. I pour a solution of potassium iodide into it, not drop by drop, but somewhat carelessly, and shake it up in the bottle at intervals, and as a result, we get a very fine emulsion. You would find if you reversed the operation, and put the iodide into the collodion first, and then added silver nitrate, you would have precipitated the iodide of silver at the bottom of the bottle, and in a form which would not emulsify at all. My advice to those who wish to make collodion emulsion (and gelatine emulsion) is to add the silver to the collodion (or gelatine), and then add the haloid salts afterwards, and you will get as perfect an emulsion as you choose, This formation, in so simple a manner, of an iodide emulsion, is a practical lesson which I hope will not be thrown away. I would just remark that if you examine this newly-made emulsion, you will find the iodide is in most minute particles, and that by transmitted light it is perfectly orange.

I have already showed you the colours of different haloid salts of silver under different conditions. I showed you two bromides, two iodides, and two chlorides, one of each of which had been boiled in gelatine, and the other unmodified, and you saw the different colours they transmitted, To-night I wish to show you a new form of emulsion, which is adapted to certain purposes, and which is sensitive to the red and the ultra red rays of the spectrum. If I had time I could show you that green is the most likely colour to absorb all above the red, and it was for this reason that I worked till I obtained a green-blue colour for the purpose I had in view. [The colour of the new form of bromide was shown on the screen.] I propose to try and take a photograph with the dark rays of the spectrum which lie below the red. These rays, which were discovered by Sir W. Herschel, and whose properties were examined by Tyndall, by means of the thermopile, we can now analyse by means of photography. I will first, however, show you how very sensitive this form of bromine is to the ultra-red rays. There is what looks a very uninteresting picture on the screen, but still, it is sufficiently interesting for me to explain it to you. There are now, apparently, four black smudges, and these smudges were produced as follows:—A film of green bromide was prepared, and over it was put a card, punctured with holes of the same shape as the smudges, one-eighth of an inch away from it. Above the card, and about half an inch away was placed a kettle of hot water, having a blackened surface. After considerable exposure on development, I got the image of those holes in the card developed on the plate, and the result is the photograph on the screen. So you see that the dark rays of the kettle, or rather the energy of radiation from the kettle, was able to produce an image. This particular kind of bromide is very difficult to manipulate in a lecture, but I am going to be so bold as to make an experiment. I dare say some of you here who had the satisfaction of hearing Professor Graham Bell in his late visit, heard him discourse about the photophone; that is, as you know, an instrument which produces sounds in a telephone connected to a selenium cell acted on by light. In one form of this instrument the light is intercepted by a revolving disc with alternate opaque and transparent sectors, which is traversed by a beam of light impinging on the selenium. He found, when he introduced between the source and the rotating disc a piece of ebonite, he still got the same effect, which was a matter of some interest. There were all kinds of explanations given about this remarkable fact. Some people supposed the ebonite took up the radiation, and gave it out on the other side, but I hope to show you that ebonite is transparent to the dark rays of the spectrum. I have some of this green bromide as a film on a plate. In front of that I have a piece of moderately thick ebonite. I propose to let the image of the carbon points forming the electric arc fall on the plate through the ebonite, by means of a lens. If the ebonite be permeable by the dark rays, we ought to get an image of the points on the bromide film when it is developed. As the rays have to penetrate through a mass of ebonite, I propose to give an exposure of about thirty seconds, and I dare say we shall then find we get the points fairly delineated. It would be impossible to develop this plate in this light, so I will give it to Sergeant Jackson, and ask him to place it in the developer, and by-and-bye I will throw it on the screen. [This was subsequently done].

For the sake of those who are uninitiated, I will show how very easy it is to develop an ordinary collodion emulsion plate. I am going to develop it with ferrous oxalate by means of a brush. Behind a negative is a plate coated with a collodio-bromide emulsion, and I will illuminate it by the magnesium wire. On taking it away from the negative, I place it in a little water, in order to make the developer flow, and then I brush the developer on the surface. It is rather a bold proceeding to manipulate a collodion film with a brush, but still I dare say it will answer. [The image was developed and shown.] The usual plan of developing these plates is to place them in a dish, and pour the developer over them. They can also be developed in the hand in the same way as a wet plate.

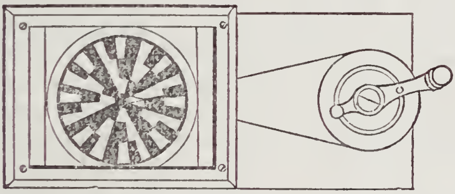
Now there is a great comfort in the collodio-bromide process, in that you are able to give local intensity to the image; and I hold that, for real artistic work, the great object is to be able to give local intensity to any part which the manipulator may judge expedient, so as to give it that tone and that vigour which an artist may think necessary. I have often asserted this before, and I am glad of the opportunity of repeating it. I do not believe any process is perfect until that power is placed in the hands of the manipulator; and the fact is that in the next process which I shall describe, you are at the mercy of your plate, and you must let come out what will.

The process which I refer to is the gelatine process, which may be described as silver bromide, held in suspension in gelatine, in the same way that it is in collodion. The origin of that, I believe I am correct in stating, was due to Dr. Maddox, who took the first picture on gelatine. I know there have been other claimants for the credit; but I believe, after consideration of the subject, that Dr. Maddox was the first person who used the gelatine emulsion with success. But of all people to whom we are indebted, there is no doubt, first of all, we are indebted to Mr. Bennett for the very perfect way in which he brought the emulsion before the public. Mr.

Kennett laboured many years in improving gelatine emulsions. He, no doubt, bore the burden and heat of introducing this process commercially; but for the extreme rapidity with which gelatine plates can at present be prepared, Mr. Bennett must be credited with the full honour. Mr. Bennett showed how a gelatine emulsion could be rendered very sensitive by keeping it at a comparatively speaking low temperature in a liquid condition for many days. Seven days was not too long a time to get full rapidity of a gelatine emulsion. Colonel Wortley afterwards claimed that he could get the same sensitiveness with heating up to 150° Fahr. for a short time and then Mr. Mansfield capped it by showing that in a very few minutes you could get the same sensitiveness by boiling. Another method was then introduced of producing very sensitive gelatine emulsions, by Dr. Monkhoven, and that was by the introduction of ammonia with the bromide of silver. The ammonia process found many admirers, amongst whom was Dr. Eder, and no doubt the process which he has described lately, of adding a large quantity of ammonia, has given very sensitive plates, and at the same time has given very vigorous pictures when the sensitiveness was not too great. But I think I may say that in England, a gentleman who is well-known amongst photographers, Mr. Cowan, has introduced an ammonia process, which certainly beats that of Dr. Eder. He emulsifies his bromide in a very small quantity of gelatine with ammonia, and then adds sufficient gelatine when the emulsion is ripened. Dr. Eder's method was to add the full amount of gelatine with the ammonia, by which means, of course, he got a certain amount of rapidity. By Mr. Cowan's method, you certainly get greater rapidity, and greater certainty. I thought it necessary to enter into this, because it has been imagined that your lecturer has been always an opponent of the ammonia process. I am not; but I honestly say I prefer what is called the boiling process in gelatine emulsion making; and if anything would convert me to the ammonia process, it would be Mr. Cowan's method.

Now what is the reason of this sensitiveness in the gelatine emulsion, for pictures can be taken in a tenth of the time necessary for a wet plate, and perhaps a thousandth that necessary for an ordinary dry plate? First of all, we have seen on the screen, in the last lecture, that it has a blue form. But you must not run away with the idea that because anything is blue, therefore the molecules composing that emulsion are blue. It may be an agglomeration of red molecules, agglomerated together in such a way, that when light is scattered by it, it gives you the effect of blue light; and I believe I am right in stating that the most sensitive emulsion is that in which the agglomeration is in a red state, that is to say, the molecules themselves are red, and the agglomeration appears blue—the blue is there by accident, if I may say so. One reason why the gelatine emulsion appears so much more sensitive than the collodion emulsion is, that you can use a more powerful developer. If you separate bromide of silver which has been emulsified in gelatine, and which gives very rapid plates, from the gelatine—and there is an easy way of getting bromide of silver out of gelatine—and place it in collodion, the extreme rapidity will be found to be gone, simply because you cannot use as strong a developer as you can with the gelatine emulsion; in fact, the property that gelatine possesses of acting as a physical restrainer comes into play; each little particle, or aggregation of particles, is surrounded by gelatine, which prevents the developer acting rapidly on them.

Again, the fact that by boiling, or by the ammonia process, you get a coarser deposit of bromide of silver, also points to increased sensitiveness, for the reason that I tried to give point to in my first lecture. For when sub-bromide of silver is acted on by the developer, you have bromine, the last atom of bromine being taken away from the silver; and the moment you have freshly reduced silver in the presence of bromide of silver, and in contact with it, the bromide of silver can no longer exist, and, therefore, you have fresh sub-bromide formed, thus:—$Ag_2 + Ag_2 Br_2 = 2 Ag_2 Br$, and this, in its turn, is reduced, and so on, until the whole of the bromide is reduced. The faintest action of light on one of these particles will therefore show itself, which it would not do were this aggregation not so marked as it is seen when looked at under the microscope. Another reason of the increased sensitiveness is this (and I have no doubt it aids it very materially), that if you boil or heat bromide of silver, or any haloid salt of silver, with an organic substance, it has a tendency to separate into the metallic state. So by boiling, for instance, a gelatine emulsion of silver bromide, the silver has a tendency to separate into a metallic state; in fact, the bromide of silver then is in the state of very tottering equilibrium; the bromine is ready to be given off at the very slightest disturbance of the molecule, much more so than before it is boiled. I think the fact that you so often get fogged emulsion when you over-boil, is proof of the statement that I am making. Now, if you were to ask me to illustrate the sensitiveness of a gelatine plate, I should take you down to the exhibition below, and I should point to you first, not some of those marvellously instantaneous photographs which you see, but I should just point out two, one by Mr. Henderson, which is a photograph by moonlight [afterwards exhibited on the screen at the concluding lecture], and another by Mr. William Brooks, which is a photograph of some underground cellars at Reigate, taken by lamplight. I think, if anything can show what gelatine plates can do, it is the fact that candlelight and moonlight can be utilised for impressing the gelatine surface with an image. I have here another proof, perhaps, which will interest you as showing you how rapidly a gelatine plate can act. I propose to take an image of a rotating disc, having alternate transparent and opaque sectors, when illuminated by the light of a single small spark. I have here an ordinary plate electric machine, and six small Leyden jars, together with a discharging machine, the knobs of which are placed five millimetres apart. If the Leyden jars are charged to a certain point, the spark will leap across between these two knobs. The light from that feeble spark will illuminate the rapidly rotating disc which I hold in my hand, behind which is placed a gelatine plate. [The apparatus was charged, and the spark passed between the knobs, illuminating the disc. The plate was then developed and shown.] The image, you see, of the rotating disc is perfectly sharp. [The disc was apparently motionless.] I dare say it will interest you to know with what speed that photograph was taken. The duration of the electric spark, for a distance such as I have here, has been measured, and found to be 42-millionths of a second. You have now some idea of the immense velocity with which the spark travels, and the extreme sensitiveness of the plate which I employ. This recalls to my mind a very early experiment, made in the daguerreotype days, where a piece of newspaper was placed on a rotating wheel, and by the light of a spark obtained from a battery of fifty large Leyden jars, a photograph was taken of the rotating newspaper. I believe the words were tolerably well defined. The time of passage of the spark was greatly longer than that which I showed you first, and immensely thicker and more luminous. I should suppose the spark from the large battery at the Royal Institution would take not less than a thousandth part of a second to travel, so that you see they were labouring under better circumstances than we are here. I have taken a photograph of this rotating disc in the camera, with only a spark from one jar, but it was rather a ticklish thing, so I preferred to carry out the experiment in the way I have done, rather than to risk a failure. But you may take my word for it, that if you had fifty Leyden jars, you could take a portrait of our Chairman with the greatest ease, by a flash from the spark, in about a thousandth part of a second.



Dr. Vogel has recently introduced a new kind of emulsion, which is a sort of mongrel between collodion and gelatine emulsion. It is made with acetic acid, gelatine, pyroxylin, and bromide of silver; but I will not coat a plate to-night with it, as the smell of acetic acid is very strong. It is a very good emulsion, very clean, and very fairly rapid. I pass on from this, merely saying that plates are more readily coated than by gelatine emulsion, but less so than with collodion emulsion.

But we come now to a decided advance in photography, and that is the doing away with glass as a support for the emulsion. Anybody who has travelled, and had to make mountain ascents, will know perfectly well that glass is a serious drawback to the mountaineer; he would do anything to save himself the infliction of taking twelve whole plates up to the top of Mount Blanc. My friend, Mr. Warnerke, who is generally to the fore in all matters of photography, was to the fore in doing away with glass for carrying collodion films, and is now to the fore in doing away with glass for gelatine films. He has perfected a process by which the photograph is taken on paper instead of on glass, and he has kindly brought me here some illustrations to show the method pursued. First of all, he has a sensitive tissue, which can be made of any length. I do not know whether he has made it a mile long, but certainly a great many yards, and it can be rolled on a roller, and exposed in the dark slide. By simply turning another roller, a fresh surface is brought into the plane of the focussing-screen. The sensitive tissue is developed in the ordinary way with alkaline development. Here we have it in the developed state. The film can be either stripped off, or else transferred to glass. In the latter case, we come to another point, which is a distinct advance in photography. Mr. Warnerke has found that when you develop a gelatine plate with alkaline development, that is to say, with pyrogallic acid and ammonia, the parts which have been acted upon by light, and which have been developed, become insoluble in hot water. He thus is able, after development, instead of using the hyposulphite bath to fix the print, to transfer it to glass, and wash away with hot water the parts of the film which have not been acted upon by light, and he gets a transparency such as I hold in my hand, and which no doubt you will examine with great interest by-and-bye. It should be noticed that, to do this, it is necessary that the back surface of the gelatine film should be exposed to the water, as in carbon printing, and this is secured by transfer to glass. Mr. Warnerke is not satisfied with doing away with glass for the camera, but he does away with glass for printing; and in order to accomplish this, he re-transfers the negative from the glass to a sheet of gelatine. I may say that the glass is freshly collodionised, which enables the film to strip off readily. In the picture before you we have an illustration of the gelatine film ready for printing, and here we have the print taken from negative. An advantage of these film negatives is, that you can print from either side, each one yielding sharp prints, which is a desideratum when using the single transfer carbon process, and other such processes where reversed negatives are required. I think that Mr. Warnerke has really made a very great advance by enabling us to do away with glass. I only hope the time will come, before very long, when not only he himself, but his friends and the public at large, will be able to avail themselves of this excellent invention which he has now been cogitating for some time. I, myself, know he has been working at it for nearly two years. There is another part of his process which I shall have to speak about presently. But before leaving this part of the subject, I wish to call your attention to the "reason why" of the invention. I do not like taking anything on trust, and I do not like seeing a thing and not knowing the reason of it. I hope that Mr. Warnerke will agree with me, when I say I think I have found the explanation of the insolubility of the film which has been acted upon by alkaline development after exposure to light. If you take a gelatine plate and expose it from the back very strongly to the sun-light, behind a negative, and then put it in tepid water, you will find there is a tendency for the part which has not been blackened by light gradually to dissolve away, and to leave the black image formed by light undissolved. What is the meaning of that? It means this, that bromine is liberated from the silver bromide, and the bromine renders the gelatine insoluble. If you take bromine and brush it across a plate, and put it in hot water, you will find where the bromine has acted, there the film will refuse to wash away. Again, if you take bromine water, and act in the same way upon gelatine emulsion with which plates have been coated, you will find the gelatine emulsion becomes insoluble. I believe the rationale of Mr. Warnerke proves that bromine is liberated in the gelatine, during the act of development. Now, you may say that the bromine is absorbed; so it is; but what becomes of it? If you add sulphite of soda, as in Mr. Berkeley's developer, I think Mr. Warnerke will bear me out in saying that there is no insolubility created by development. If you use a ferrous oxalate developer, there is no insolubility of the film created by such development. Why is that? Simply because the sulphite of soda is able to mop up the bromine, as is also the ferrous oxalate developer, as quickly as it is liberated, whereas the pyrogallic acid and ammonia is not able to do so. I have thrown this out as a hint for experimenters who wish to work further in this direction.

In the matter of gelatine films, we have Prof. Stebbing's, which are really workable. The gelatine emulsion is apparently flowed on an insoluble gelatine film on glass, which is then stripped. They are developed by placing them on glass. I have here examples of negatives taken on such films.

But I must now hurry on. The next point I am going to touch upon is the enlargement of negatives. Now, the question arises, how are you going to get an enlarged negative? Of course you will at once say "get a transparency by contact, and then enlarge it in the best way you can." The best way you can is, of course, to do it very perfectly indeed; but, unfortunately, by the wet process, an enlargement is very often sadly defective. The best way which

I know of getting an enlargement of a negative, is one which was brought forward a few years ago by Mr. Valentine Blanchard, and it is this. He takes the original negative which he wishes to enlarge, and places it in an enlarging camera. He then takes a transparency of the exact size which he wants his negative to be. He next takes a piece of common albumenised paper, and prints that transparency upon it, and by this means gets a very soft and beautiful negative. If you have a hard negative, it is almost impossible to get a soft transparency by the wet plate process, but by this artifice of "printing out" your transparency, and using that as a negative, you get a decidedly soft paper negative. If you trace the reason of this, it is as follows:—When the albumenised paper is acted upon by light, we know it blackens immediately, and, of course, light acts less violently on the underneath portions where it has been blackened. Thus, in printing from a transparency, the most transparent portions first blacken, then the next most transparent part blackens, before the first blackened part becomes too intense, and so on. So you see, by the shielding of the film by the blackening action, you are able to get a softness which you otherwise would not get. I have here such a negative, which I prepared several years ago, by which you see we get some of this softness. Mr. Blanchard, I am sorry to say, has gone back from his old love, and recommends now, that you should use a gelatine plate instead of the albumenised paper. A gelatine plate is a very good thing, but I think the albuminised paper negative beats it, when you have to enlarge from a very small negative to a very large one. I think the grain of the paper, too, is an improvement in large photographs, and you get no grain in a gelatine negative. I will next show you how to obtain a paper negative by the ordinary lantern, but I must ask you to bear with me if I keep you rather long. I will make an enlarged negative from a transparency taken from one of my Egyptian negatives, developing it before you. This is ordinary paper, to which a couple of washes of bromide of potassium were given, and which, when dried, was floated on silver nitrate. Half a minute's exposure to the light coming through the transparency will be sufficient. I shall use the developer, which I recommended to your notice some time ago, the ferrous-citro-oxalate. [The negative was developed and shown to the audience.] So much, then, for paper enlargements. We now come to another great advantage of the gelatine process, which is that by it you can get soft transparencies. I am aware that it is said there is a certain amount of blurring in gelatine transparencies, but I am not prepared to say that is necessary, in fact, I should say it ought not to be the case, as I think I shall be able to show you in the next lecture. Therefore, if you have a hard negative by the common process, it is always possible, by the gelatine proccess, to get a soft negative from a gelatine transparency, in which case you can substitute for the paper, such as I used just now, a gelatine plate, or a collodion plate, or a wet plate, whichever you prefer. The main point to aim at in getting enlarged negatives is, to get thin, delicate transparencies, with every atom of detail present in them. If you get that, you can always get a decent enlarged negative from them. If the detail is blocked up, you will not do so, unless you use a paper printing process, such as I showed you, with the albumenised paper negative.

After these preliminary remarks, I propose to show you one of the new applications of the gelatine emulsion process, and that is the development of a print on paper coated with gelatino-bromide. The paper is prepared by coating ordinary paper with gelatino-bromide (of the most sensitive kind if you like). Such paper can then be exposed to the image formed by an ordinary magic lantern; by that means you can get can get an enlarged print. The lantern before you is a triple-wick oil lamp, and I think you will be able to see that I shall get a very good print indeed from the negative, which is at present placed in front of the condenser. [The negative in the lantern was a view taken by the lecturer of one of the caves of Ellora, in Western India. An exposure of half a minute was given, and then it was developed by the brush, with a ferrous oxalate developer.]

For my own part, I prefer gelatino-chloride paper, as it gives a very black image which beats the bromide out of the field altogether. The reason why the tone is black, is that chloride of silver, when developed, is developed in two states, in a red, or ruddy state, and also in a green state, and when you put red and green together, the result is not far from black. I think you will see, when this is developed, that we shall have the ruddy state first. I use the ferrous-citro-oxalate. It will not bear the ferrous oxalate at first, although it may be brought out more quickly with it. Now, if I turned up the light, you would see it in the pinky state; as it goes on, the pinky state gives place to the green, and the two together make up the black, and you will see afterwards that this black is of a most beautiful hue. I want particularly to call attention to the beautiful black tone it has. On the table there are some plates prepared with gelatino-chloride, to show the same black tone.

[An enlargement on gelatine chloride paper was here made, and developed before the audience, the developer used being the ferrous-citro-oxalate.]

We may thus say that an advance has been made, when, by an ordinary magic-lantern, with a good negative, you can get a perfect enlarged paper print by development. Perhaps they will not have that lustre which albumenised prints have, but it is a matter of taste whether you like that gloss or not.

I have now to allude to Mr. Warnerke's invention again. He has found that he is able to mix with his gelatine emulsion colouring matter, and you will at once perceive the value of this. When you wash away the unaltered bromide of silver that is not acted upon by development, you get silver left behind, plus the colouring matter embodied in it. I have a developed print containing colouring matter, and to save time, I have placed it on a transfer paper. The image was developed with alkaline pyrogallic acid, and was placed in contact with gelatinised paper, rendered insoluble by chrome alum. I propose to wash away the soluble gelatine containing the bromide of silver and the pigment, to show what a power this discovery places in our hands. I first place it in hot water, and as soon as it has soaked a little, the outside paper on which it was developed will peel off, leaving the gelatine film on, what we may call, the transfer paper. The subject is one of Mr. England's statue subjects, of which he was kind enough to give me the negative. Stripping away the paper on which the print was developed, the picture remains on the transfer paper, and we have the image waiting to be freed from the soluble matter. The print before you was taken in my laboratory with the electric light; and had a very short exposure. The soluble matter is now gradually washing away, and the whites are gradually coming out, and we get a picture in the colour of alizarine. You can get almost any variety of colour; but it is not every colour the operator can use, because some would destroy the sensitiveness of the gelatino-bromide, but most colours he can use. I can hardly thank Mr. Warnerke enough for the trouble he has taken in illustrating this part of my lecture for me. He has furnished me with pictures showing a variety of tints, from sepia and photographic purple to almost any colour. This I may claim as a great advance in photographic printing, and I hope, before long, the public will have the advantage of this invention, which at present they have not.

General Notes.

Cooling Apparatus.—A new method of cooling rooms by what may be termed a chemical lung, or punkah, might prove useful in India and other tropical countries. The following is a description of the apparatus:—Attached to the frame of the punkah is an endless blind, passing round rollers at the top and bottom. The bottom roller is a trough, which contains a solution of a caustic alkali. At every swing of this punkah a wheel and ratchet arrangement causes the rollers to revolve, thus drawing the sheet or blind through the solution. The wet sheet swinging to and fro, takes up from the air the sulphurous and carbonic acid gases, as well as some organic matter. Brought to the test of experiment, this plan appears to work successfully. In a small room, 18 feet by 15 feet, and only 8 feet high, 50 jets of a gas-stove were set burning for an hour, with the windows and doors of the room closed, and to make it still further unfit for animal life, a quarter of an ounce of sulphur was burnt in it. The punkah, charged with caustic soda, was here set to work, and in ten minutes the temperature was reduced from 85° to 70°, and the air was made sufficiently fresh and pleasant for 20 persons crowded in the room.

Irish Fisheries.—From official returns it appears that of mackerel captured in Irish waters in 1872, the number of boxes (of 120 fish each) was 60,000, and the amount realised, £52,000; in 1881, the number of boxes was 129,702, and the amount realised, £146,943. Of oysters taken in 1872, there were 16,675 barrels (of 450 oysters each), in 1873, there were 13,640 barrels, and from that time the number continually decreased, until there were only 4,881 barrels in 1881. The quantity of salmon, herrings, mackerel, and cod exported from Irish fisheries to London, Birmingham, Bradford, Leeds, Liverpool, Manchester, Nottingham, Sheffield and Wolverhampton in the years 1873 and 1881 respectively, was as follows:—

	1873.	1881.
Salmon, in boxes of 120 lbs....	40,600 ..	54,532
Herrings, in boxes of 2 cwt.....	100,041 ..	115,233
Mackerel, in boxes of 2 cwt....	71,224 ..	83,459
Cod, in boxes of 2 cwt	46,955 ..	54,365

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Proceedings of the Society.

CANTOR LECTURES.

RECENT ADVANCES IN PHOTOGRAHY.

By Captain Abney, R.E., F.R.S.

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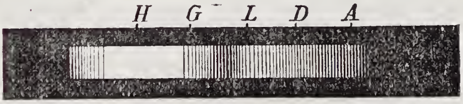
Lecture IV.—Delivered February 20th, 1882.

I have already shown you the example of a production of a positive from a negative, having previously to that demonstrated the production of a negative from a positive. I wish to commence this evening by showing you the production of a positive picture from a positive picture; not that there is anything essentially novel in it, but it points to a moral to which I shall presently have to draw your attention. What I propose to do, is to take some sensitive iodide paper, expose it to light, and then soak it in a weak solution of potassium bromide, and next expose it behind a positive on glass. On developing, I think, the probabilities are that we shall get a positive picture. It is perfectly immaterial, as I am going to expose it to light, whether the paper sees the light now or not, and the small modicum of light we have here will make very little difference to this comparatively insensitive paper. [The paper was shown to the audience.] I now burn a small quantity of magnesium wire, in order to fully expose the sensitive surface. If I were to put a developer on that paper as it is now, it would at once blacken. Instead of applying the developer, I will place it in the solution of potassium bromide, then expose it under a transparency, and subsequently develop it. I will give it rather a prolonged exposure, for this paper is not very sensitive, and of course, the time in which this positive is produced depends on the sensitiveness. [A lantern image was thrown on the paper.] Half a minute with this light would be sufficient, but for safety's sake I will give 20 seconds longer. I will now develop the picture with ferrous oxalate, and a positive instead of a negative appears, as it would do in the ordinary way. In other words, the lights are reversed.

Before I draw any conclusion as to this, I will show what part of the spectrum produced this positive picture, because this is an important item in the deduction I shall have to draw. I will take another similar piece of paper, and throw the spectrum upon it. You will recollect that we applied a solution of bromide of potassium to an exposed piece of paper, and that it was then exposed to the image. I will, therefore, expose this second piece of paper to the light from the magnesium wire, as before, and immerse it in a dish in which there is a solution of potassium bromide, and place it in the spectrum. I leave it to be acted upon for about half-a-minute. This I propose to develop on the screen, so that you may see absolutely the part of the spectrum which affects the paper. If everything goes right, there ought to be a bleaching action in the blue rays, and the red rays also will exert a bleaching action if the exposure is continued for some time. I am not going into that part of the subject during my lecture, as it will carry me into too much theory; I simply want to show you the practical result of bromide of potassium on an exposed paper. On developing, you see we have the bleaching action caused by that portion of the spectrum which I mentioned.

Fig. 1.



Now, if you will allow me, I will point the moral. These may seem paltry experiments to bring before an audience, but those of the audience who are interested in gelatine plates, and I believe there are a great many here who are, will now, perhaps, be able to draw an inference equally well with myself. All gelatine plates, without exception, I believe, are prepared with an excess of soluble bromide, and I will now ask you to consider what happens, supposing any bromide is left in the film. While the light is acting on the film, the bromide of silver is decomposed, and at the same time the bromide of potassium (or ammonium), is also being decomposed, and undoing the work that the light has done upon the bromide of silver; so that you see that the sensitiveness really got by gelatine plates with an excess of soluble bromide is only the difference between the effect of the light on the silver bromide, and on the bromide of potassium (or ammonium). I think those two experiments ought definitely to settle that gelatine plate-makers have not, as yet, obtained the highest sensitiveness possible, simply because they prepare their emulsions with an excess of soluble bromide. I may say, with reference to this, that Dr. Eder has recently shown that on immersing gelatine plates in a weak solution of silver nitrate, (in which is a little citric acid), though strong enough to neutralise any soluble bromide which may be left behind, an increase of sensitiveness, two or three-fold, is produced. The problem to be solved by gelatine plate-makers is this—How to get rid of any possible excess of soluble bromide in their gelatine films? When they do that, no doubt they will get more rapid plates even than they have done at present. I hope the effect on the minds of the audience of these two experiments will not be thrown away, as now, you have seen that the same rays which act upon the silver bromide, act upon the potassium bromide. I will now show on the screen those interested in the chemistry of the subject the formula which represents the action which takes place—

$$\text{(I.)}\quad 2Ag_2I + 2KI + H_2O + O = 4AgI + 2KHO$$

$$\text{(II.)}\quad 2Ag_2Br + 2KBr + H_2O + O = AgBr + 2KHO$$

In the first equation (I.) we have silver iodide, but a similar formula (II.) applies to bromide of potassium, and bromide of silver. In (I.) there is sub-iodide of silver, iodide of potassium, water and oxygen, and that forms iodide of silver, potash, and iodate of potassium. When you have more iodine or bromine liberated, we get—

$$\text{(III.)}\quad 6I + 6RHO = 5KI + KIO_3 + 3H_2O$$

or the iodine and potash combine, and form fresh potassium iodide, water, and iodate of potash. When this reaction is finished, we have to go back to the equation (I.), and the same decomposition is repeated. The oxygen of course is a crux; where does it come from? It comes from the air. It will find its way through the gelatine. Gelatine is not impervious to the air. Dr. Eder has very recently found that this reaction does not take place when there is no oxygen present. So that you see, in order for this reaction to take place, there must be oxygen obtainable from some external source. If you prepare your emulsion with hydrochloric acid, as some do, you have nitric acid left in the film, and that will supply the necessary oxygen for this formula to take effect. I need not enter into details of what takes place with the nitric acid, it is sufficient to say that the nitric acid will supply the oxygen.

This leads me next to consider what causes the destruction of the photographic image. You may destroy the image on a photographic plate, or photographic paper, by any substance which will readily part with oxygen. You can destroy it, for instance, by bichromate of potash; you can destroy it by any of the ferric salts; or you can destroy it by oxygen-yielding substances, like permanganate of potash; ozone, per-oxide of hydrogen, or hydroxyl; in fact, there is hardly any substance which will part with oxygen which will not destroy the developable image; the photographic image remains behind as a rule, though not always, but these reagents prevent it becoming developable. Here is paper prepared with bromide of silver, which has been already exposed behind a negative. After immersion in water, I propose to apply to it some of these destructive agents which I have already mentioned. First I will give it a streak of bichromate, next ferric oxalate, and next permanganate of potash. If everything goes right, on those parts to which these solutions have been applied, the image will be destroyed, or almost destroyed, and a little longer application of the solution would entirely destroy it. I now develope; part of the image appears, and you see those parts which have been brushed over with the above solutions entirely refuse to appear. This demonstrates then that oxidising agents will destroy the developable image.

Now, I do not wish to detract from any developer, but this shows you the care you should take in seeing that your ferrous oxalate developer is tolerably fresh, for if you have a large proportion of *ferric* oxalate present with it, it will be very liable to "slow" your plates, and those who are photographers will know what that means. If you take your pyrogallic acid which has been fully oxidised, you will find that it will play you the same trick as this ferric oxalate does, so that neither the ordinary alkaline developer nor the ferrous oxalate developer is certain to give you the best results unless it is fresh. Photographers take warning, and when using a ferrous oxalate developer, use it fresh! If you use the ferrous-citro-oxalate which I have introduced so often to your notice, you get the same result; it has the same bad qualities that the ferrous oxalate has.

I now come to the one other destructive agent of the photographic image, and that is bromine; and while I am on the subject, I should like to show you a neat way of exposing a transparency. It is not mine, and, therefore, I can praise it. Through Mr. Bolas's kindness I have here a phosphorescent plate made with calcium sulphide, which I propose to expose to light, then to use it as a source of illumination for obtaining a transparency. I now expose the phosphorescent plate to the light from magnesium wire, and then placing it over a negative, behind which is a sensitive plate, expose for 30 seconds. I next take a little bromine water, and brush it across the exposed sensitive plate; I rinse with water, and develop with ferrous oxalate. As I showed you in a former lecture, the ferrous oxalate is a very fair medium for cutting off the radiation which affects a bromide plate, and so I can develop it before you. The image begins to appear, and by degrees we have the image pretty perfect, except that, where the bromine has acted, there the image is totally destroyed, or very nearly so. This is a very simple experiment, but I did it for the purpose of leading you to another important point with regard to gelatine plates. Most of you are aware that when you have a pure bromide plate, it is very easily reversed as they call it, that is to say, instead of a negative there is a tendency for it to become a positive. The reason of that, I think, will be found in a measure in the experiment which I have just showed you. When you expose a bromide plate to the effects of light, anybody who has at all a keen sense of smell will perfectly well know there is some substance liberated which is somewhat pungent, and it will be found that it has a smell of bromine. If, therefore, you expose a plate for a considerable period—longer than it should be, that is to say—to light, what is the first effect? The first effect is for the bromide to be decomposed at the surface, and bromine to be liberated in a gaseous state, part of it will ascend into the atmosphere, and part of it will have a tendency to go down into the film. As the light penetrates still further, the energy of the radiation will split up the bromide below into bromine and sub-bromide, and so on, and the part beneath the first part will be passed over by bromine liberated from the molecules immediately below; so that, by a continuation of this emission of bromine, you get, first, the top practically saturated, as it were, with the bromine from the lower particles, and, as we have just seen, when you have bromine applied to a plate that has been acted upon by light, it destroys its developable powers—in other words, it forms fresh bromide of silver. If such is the case, you ought to have a reversal of the image at the top of the plate, and non-reversal probably at the bottom. I think I can show you this in the lantern. I exposed two gelatine films, such as are prepared by Mr. Stebbing, behind a plate which is prepared with squares of different thicknesses of coloured gelatine; that is to say, it allows different gradations of light to pass through. On these graduated thicknesses of gelatine are painted opaque numbers. No. 1 shows the thinnest amount of gelatine, and No. 25 shows the thickest amount of gelatine. With a moderate exposure to light of a gelatine plate behind such a screen, the whole of these opaque numbers ought to appear transparent on a more or less opaque background plate, when developed and fixed.

Now I will show you an experiment demonstrating what over-exposure will do. Two of Stebbing's films were placed face to face, and exposed for a considerable time to light behind a graduated screen. The results are before you. On the film nearest the graduated screen, the whole of the numbers as far as 20 are reversed; that is, appear opaque on a transparent background. On the bottom film, except No, 1, the whole of the gradations are perfect; that is to say, there is not a reversed image at all. Thus you see that a reversal takes place in the top part of the film, and not at the bottom. That is the point I wish to bring before you. No doubt this reversing action is partly due to the bromine which passes over the molecules which lie immediately below it. Not only that, however, but, if you enter into the chemistry of the thing, you will find that gelatine will take up the bromine, as it is liberated, though slowly;

and that, when bromine combines with gelatine, one of two things happen—it either replaces and liberates hydrogen, or else a molecule which has the properties of hydroxyl. Either of these will combine with bromine to form hydrobromic acid, or yet another compound of bromine, which is equally ready to destroy the photographic image as bromine itself, or as any oxidising agent such as I showed you just now.

Now, before I quit the subject of oxidising agents, I should like to introduce to your notice a very remarkable utilisation of this oxidising process of photography which was proposed, and not only proposed, but carried out—there is a great distinction between the two, for we often hear propositions made by men who perhaps never have the pluck to carry them out—by Mr. Bolas. He, first of all, took an ordinary gelatine negative with proper gradations of light and shade. Then he wanted to reproduce it, so he took a gelatine plate, and immersed it in bichromate of potash, allowed the film to dry, and then exposed it to light behind the negative to be reproduced. You will see that in this exposure to light he had an oxidising agent present in his film, and that the oxidised parts were acted upon by light, leaving the other part intact, and by that means he got a reversed image. Now, he was aided by the fact that the gelatine is rendered insoluble to a large extent by bichromate of potash, but still that is not everything. On the screen is the original negative, and also the reproduced negative. These I had the pleasure of seeing manipulated at the Photographic Society. In regard to this process, we have a curious case of re-invention. We have lately had in the papers devoted to photography letters from France, in which a certain Captain Biny has been supposed to have invented this process. Across the Channel they have not the same facility for reading English, I am afraid, that we have for reading French. However, the discovery of Captain Biny's is nothing more or less than Mr. Bolas's discovery, and I hope Mr. Bolas will put in a claim for it.

Another use of oxidising agents is to enable us to get rid of fog. If you have a gelatine plate which has been exposed to light, and so has been fogged, you can get rid of that fog by immersing it in bichromate of potash. I have here a fogged emulsion plate of which the upper half has been immersed in bichromate of potash, the bottom half is completely veiled, but you will notice how beautifully clear the top half is, where the plate has been immersed in the bichromate.

The next subject I wish tô treat of is one which has been much misunderstood by many. The theory involved is not new to myself, but I think the results I shall show will be new as far as the audience is concerned. On this plate is pasted tin-foil, with various figures cut on it; first, there is a circle, then a line across, and so on. The image of these figures I now throw on a monster gelatine plate, the thickness of the glass being some $\frac{1}{4}$ inch. Now, I ask you to observe what you see on it. You see every figure surrounded by a halo. Thus, you see, the circle is surrounded by a ring. You have a halo round every part of the images. If you come to analyse it, you will find that the halo surrounding the bright cross is made up of a series of rings similar to that ring which surrounds the clot of light. Now, I have here some wonderful elixir to get rid of these haloes. I touch the back of the plate where the cross falls with asphaltum, the halo vanishes. I move the plate a little, to get a fresh surface, and with red varnish I again touch the back of this plate, behind the cross, and now I have a white cross on a red background; to put the matter in words, according to the medium you place on the back of the plate, so is the reflection toned down. If I use a red varnish, this halation will have but little effect on the photographic plate, because it is red, and these red rays do not much affect the production of a change in the sensitive salt. The most perfect cure for halation is Brunswick black; there is no reflection from the back of the plate, and by that means you get rid of any tendency to fuzziness of the image, which was often a disgrace to photographers' pictures. I will now throw on the screen one or two of the absolute photographs showing different halations. One is from an ordinary plate, the other from a thick glass plate; when the thick one comes on the screen, instead of the cross remaining where it was, it was spread out considerably. [Shown.] When you come to analyse it mathematically, you will find the diameters of these rings depend on the thickness of the glass, together with the critical angle of reflection for the glass employed: that

FIG. 2.

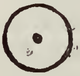
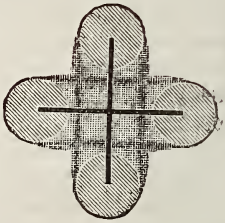
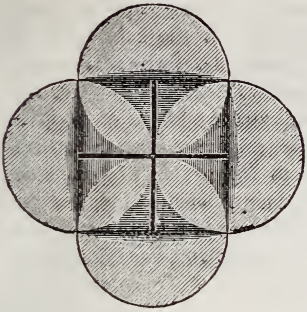


FIG. 3.



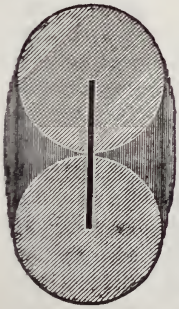
the greatest intensity in the ring is fixed by the critical angle alone. That is a very important point, because there has been a good deal of controversy about it, which I will not enter into now. I think what you saw on the gelatine plate, and what you see on the screen now, ought to settle that point for ever. I will show you some plates taken with an asphaltum backing; it is of no use giving improper backing; if you have anything which will reflect blue light, you get this blurring of the image. With a plate prepared with a backing of asphaltum, you can even expose it to a bright image of the sun without getting a halo round it. An astronomer in Germany has recently deluded the French Meteorological Office into believing that he has photographed the corona in full sunlight, but when you come to inquire into the matter, this corona is nothing else than the halation; not only that, but he has found the most extraordinary rays shooting out from it at certain times. When, however, you come to investigate the question, you will find that these wonderful rays, which are supposed to proceed from the sun, and thus to influence our earth, are nothing more than a certain reflection which the laws of optics tell us ought to be there.

FIG. 4.



Here is a simple method by which photographers can always be sure of seeing what amount of blurring they may get. If they take the trouble to place a gelatine plate, or any plate they wish to try, in contact with a slit cut in tinfoil, and then look through the back of the glass at a strong light, they will find it has more or less blurring round the slit.

FIG. 5.



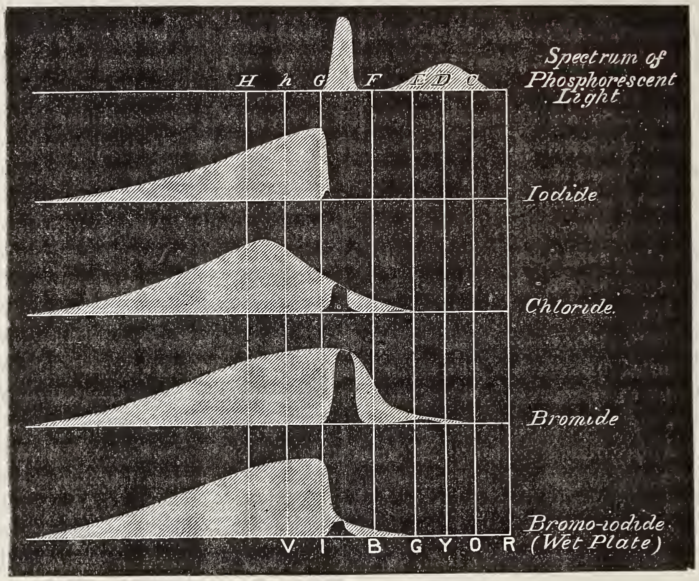
Having so far digressed, I may say that the reason why you get apparently greater reversal in a photograph taken on a glass plate than you do in a paper negative, is because there is none of this halation to help it.

There is also another reason why reversal is more difficult to secure on paper, in that the bromine has two ways to escape, one through the paper, and the other through the surface of the bromide. I hold in my hand an example of reversal on paper.

Now I will show you how you can get rid of this reversal altogether. The film before you was exposed 60 seconds behind a negative to the full sunlight, yet there is no reversal on it. How is that? Simply because I gave it something which, instead of allowing the bromine to attack the bromide of silver, that had been altered by light, at once took it up. The substance employed was potassium nitrite. This shows that, if you want to get rid of the reversal of the image, you must give the plate something which will very rapidly absorb bromine, and I should say something, if possible, which is not organic, for the reason I have already stated to you. Now, is it possible that you can give a film something of that kind, I say it is quite possible to do so, and those photographers who are experimenters no doubt might turn their attention to this point. In the meanwhile, I may say that the addition of iodide to bromide in a plate is sufficient to a very large extent, because, as I showed you in a former lecture, the sub-iodide of silver acts as a sensitiser to the bromide of silver; the consequence is, that those films which contain a large quantity, or even a small quantity of iodide, do not reverse in the same horrible manner as a pure bromide film will do. Perhaps a certain amount of anxiety may have been created in photographers' minds by a recent article in one of the photographic papers, in which a doubt was raised as to whether they can get iodide in their films. Let me once for all reassure them. If you have iodide of potassium, and bromide of potassium to combine with silver nitrate, iodide of silver will always be present in your films; for the iodide is formed always long before the bromide, and, therefore, the scare as to whether you have iodide in your plates or not, is one which need not be seriously entertained. As far as chloride goes, I leave that for another occasion to remark upon; but once for all, if you have soluble iodide present when making an emulsion, you must have silver iodide in the film, and this will act as a sensitiser to prevent the reversal of the image.

I now come to a description of a most useful instrument introduced by Mr. Warnerke, which is known as a sensitometer; it consists of squares of coloured gelatine of different opacities through which light is allowed to fall on a sensitive plate. This sensitometer is meant to enable you to judge of the comparative rapidity of your plates. You have seen on the screen some of the images produced on glass, on paper, or on films, by the exposure of such a tablet as this, and it is a most useful instrument. To my mind, no photographer, be he amateur or professional, should be without one, or one similar to it. Mr. Warnerke has been the first to adapt this sensitometer to practical purposes. There are others in the field, of which we have a notable instance in that of Mr. Spurge; but for the time being I propose simply to call your attention to Warnerke's sensitometer The method of operating is very much the way in which I operated just now. First, a phosphorescent tablet is exposed to magnesium light, and then allowed to rest a minute, placed in contact with the sensitometer plate, which is in front of the plate to be tried. The exposure lasts for half a minute, and the plate is then developed. The last distinct number seen upon the plate by reflected light, before fixing, is read off. By a simple table you are able to see the comparative sensitiveness of two particular plates of the same kind. Here, owing to Mr. Warnerke's kindness, I have an enlarged apparatus, showing the way in which you read off the sensitometer. Suppose, for instance, you find the last number on one plate to be 20 in the one case, and 16 on another, if you take two such plates out in the field in the same light, and you want to know how much exposure to give in the one that registers 16, knowing that necessary for the one reading 20, how are you to do it? You take Mr. Warnerke's instrument, such as we have here (but in miniature, of course), you place this opening at 20, you then cast your eye on the ring, look at 16, and find that the one that registers 20 is three times more rapid than the one that registers 16, and expose accordingly; so, in the same way, if you had one that registered 25, which is a very high degree of sensitiveness, and another 12, you would find that you would have to give the one 36 times more exposure than the other. I recommend this to the notice of practical photographers; I do not wish to act as an advertiser to Mr. Warnerke's sensitometer, but I merely advise them to get some sensitometer, so as to prevent groping about in the dark as to what exposure to give to plates of different degrees of sensitiveness. There is nothing like picking a hole in your friends, if you possibly can, and now I am going to pick a hole in Mr. Warnerke's sensitometer; it is not a very grave one, but still, one which ought to be noted; I want to show you what happens, supposing you measure all kinds of plates by such a sensitometer. First, let us examine what kind of light is emitted by this phosphorescent tablet. You will see, if I expose it to the light, it will phosphoresce, and the stronger the light the more it phosphoresces. Now, here we have a spectrum of the phosphorescent light, and when you come to examine it by the eye, it is found that there is one bright band in the indigo: there is a very faint light coming down as far as the red. When you photograph such light in the photo-spectroscope, nothing is indicated except the existence of the indigo band of light, and nothing in the violet or beyond; it is almost a monochromatic light which it emits, as

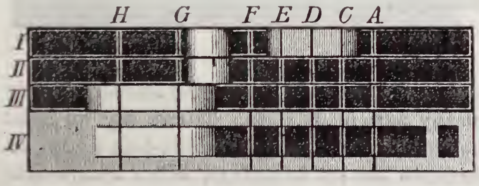
Fig. 6.



far as photography is concerned. Supposing we have to try some plate, the composition of which is unknown, with such a sensitometer, it will be seen that we may fall into serious error. On this diagram the mountain represents the intensity of light which is painted by the phosphorescent light on a plate. Supposing the plate only contained iodide, you will really see that the little mountain, which only affects the iodide, is only $\frac{1}{90}$th part of the whole mountain which would be there if you are using white light. If you only use chloride, it would be showing one-third only; whereas, if you use bromide, it would be unity, or as giving the maximum amount. If you try a wet plate by the sensitometer, you will find that it indicates only about one-fourth of the true value; that is to say, you would be wrong supposing you went out with a wet plate, and a gelatine plate, and exposed according to the sensitometer; you would find that you had given five times too much exposure to the wet plate, simply because the bromo-iodide is most sensitive to those rays of light which are not present in the phosphorescent light. Hence, when using such a sensitometer with phosphorescent light, you must beware what you are about, and hesitate before you draw any exact conclusions.

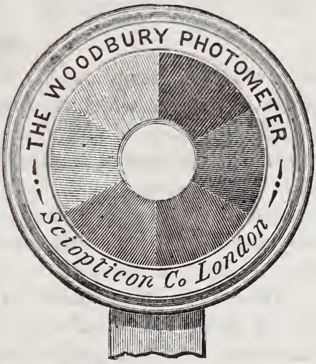
This leads me on to the measurement of the intensity of light, for if we want to know anything about our plates, we must know what brightness of light we have. I again have to allude to Mr. Warnerke; he is a most facile inventor, and the photographic world is largely indebted to him for many ingenious contrivances. He has introduced an actinometer which is dependent on phosphorescence for its value. I have here a phosphorescent tablet which has been as little illuminated as possible. Now I will throw the spectrum upon it. [Shown.] This bright spectrum of phosphorescent light extends into the ultra-violet, but stops short at the place in the indigo, where the phosphorescent light is emitted, that is to say, one spectrum ends where the other begins. Mr. Warnerke has shown us that by exposing such a phosphorescent tablet to the action of light, by an ingenious contrivance, such as you will see downstairs, he is able to tell the photographic value of the particular light. This is a most valuable discovery, because phosphoresence is induced by very nearly the same rays as those which affect bromide of silver. If I allow the spectrum to play upon a fully excited phosphorescent tablet, we get another action. You will see that the phosphorescent light is diminished where the red and green have acted. These rays extinguish phosphoresence to a very large extent. With reference to this, there is a curious fact that below the red, as we know, there are rays which exist, and which, to a certain extent, "de-sensitise" the phosphorescent film, and we have a darkening going on in that region. I have shown you this experiment, to demonstrate how you can desensitise this phosphorescent plate, viz.,—by allowing white light to pass through red or green glass, since they permit the passage of those particular rays which act as extinguishing rays. There is another very simple way, which I recommend to amateurs, of telling the amount of exposure to give to your plates, and that is by Mr. Woodbury's photometer, which is the simplest thing in the world. Here we have a piece of bromide paper exposed to light for a minute, then readoff against one of these tinted circles, according as to whichever tint it agrees with; you know what is the intensity of the light, and, therefore, what to give to a plate. A simple rule to remember is this, that if you use a bromide plate, only use a bromide paper for securing this tint; if you are using a chloride plate, use a chloride paper. Recent researches of mine have shown that the darkening intensity and the developing intensity go hand in hand; therefore, it will be found that when you have the number which gives the right tint, you may always be sure of getting the

FIG. 7.



I. Visual spectrum of phosphorescent light.
II Photographic spectrum of ditto.
III. Rays exciting phosphoresence.
IV. Rays which extinguish phosphorescence.

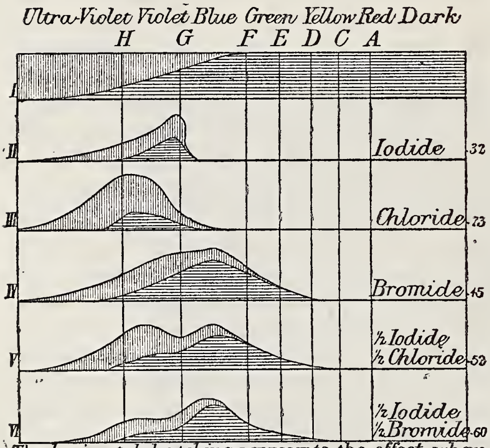
FIG. 8.



right exposure. If a tint require two minutes to obtain, which corresponds with an exposure of a plate of two seconds, and you get that tint, and give two seconds, you will not be wrong. If it requires half a minute to obtain it, give the plate half a second's exposure, and you will be right. This is as useful an apparatus as you can have for the field. I do not know about the studio, but in the field some such device as this is almost a necessity.

I want to show you the theoretical as well as the practical necessity of using a photometer or actinometer of some description. Here we have these little mountains which signify the intensity of different parts of the spectrum. There are some bright days in summer, the light of which, when spread out in a spectrum, let us represent by a rectangle (I.), that is to say, they are all of equal intensity. I do not say they are, but you can represent them as such. There are other days in autumn or winter in which the ultra-violets will very much decrease. If you judge the exposure by the eye, you may be entirely wrong, and if you are using an iodide plate, you may only give one-third of the exposure you ought to give; for chloride only one-fourth; for bromide about one-half. If you are using one-half iodide and one-half bromide, you would give only two-thirds of what you ought to give, so that the eye is no exact judge of the exposure you ought to give; it depends on the amount of rays which exist in the ultra-violet, and that can only be told by a photometer of some description.

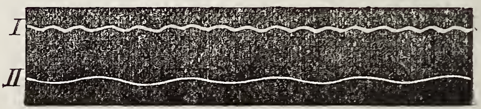
FIG. 9.



The horizontal hatching represents the effect where the ultra violet light is deficient The standard light is represented by the whole of the shaded figures.

The next thing I propose to show you is with regard to drop shutters. I could talk to you for a whole evening on drop shutters, and even then I should not have finished, for there is a great deal in the philosophy of a drop shutter of which people have not dreamed. I am sure if I were to enter into the philosophy of the thing, I should carry you beyond any endurable limits of time. I therefore, propose to show you one very easy plan of knowing what your drop shutter can do for you. We often hear said, "Oh, I exposed that plate with a drop shutter," and if the exclaimer is asked what length of exposure that was, he will probably confess that he does not know, or will say anything from 1-5th to 1-50th of a second. Now that is a very untidy way of photographing. It is decidedly misleading to say 1-5th of a second when it may be 1-20th. I will show you a way in which you can tell whether it is 1-20th or 1-5th of a second of exposure you may have given with a drop shutter. I have here a monster lens, with which, had I time, I was going to show you some tricks. It is not very valuable; I think it cost 6s. In front of this gigantic lens I have a gigantic drop shutter, and attached to the sides of that drop shutter there is a tuning-fork which cost 1s. I claim no monopoly. You take a common iron clamp, and attach it to the side of the shutter. Then you blacken a piece of albumenised paper by the side, and make the tuning fork vibrate. As the shutter drops, it traces its own vibrations, and tells you how many it has performed during the fall of the shutter. You know that an E tuning-fork vibrates so many times per second, and by simple measurement you can tell at what speed your shutter is going at any part of its path. I dare say we shall be able to see that the tuning-fork leaves its mark on the smoked glass, which I have substituted for the albumenised paper above described. Here is another trace (II) made when gravity was aided by an elastic band. [The shutter fell, and the diagram was shown on the screen.]

FIG. 10.



I find my time is more than up; but before I close I should like to show you one or two curiosities, as regards the scientific application of photography, and these are some composite photographs which were kindly lent to me by Mr. Galton, showing you what aid photography can give to anthropology. Here is a typical family composite portrait, composed of a mother and two daughters, all three faces being blended together. We thus get a likeness of the female branch of the family; then we have the father and mother, two sisters, and two brothers, giving the typical family group. Here we have another image, which is a typical group of engineer officers, and I am glad to see that they are so good looking. Here is one more, which is a typical group of sappers. I wish I had more time to go into the subject.

I cannot touch on printing processes at this late period of the evening, and therefore, I must ask your permission to close. I feel that what I have done has been very imperfect, but I have done it to the best of my ability, so far as time would permit. I may have done things I ought not to have done, but I have certainly left undone a great many things which I ought to have done, but I hope for all my shortcomings you will excuse me. That this course of lectures has caused a certain amount of interest, is evinced by the continued large audiences I have seen before me, and I hope some abler lecturer, at some future time, will be able to complete what I feel I have only commenced to do, viz., give a *résumé* of recent advances in photography.

Correspondence.

THE FIRE RISKS OF ELECTRIC LIGHTING.

A set of rules bearing on this matter has recently been issued under the auspices of the Society of Telegraphic Engineers, and it appears to me to be necessary to call attention to a few points.

The first impression created on reading them (the rules in question) is that they have been compiled with undue haste, and without proper and deliberate consideration; it being, moreover, evident that their want of clearness and definitive meaning is partly due to careless revision as regards literary composition, and partly to an indefinitiveness with respect to the ideas themselves.

We find that the telegraphists say that the insulation of the coils and conductors of the dynamo should be perfect; a condition of things altogether impossible in the present condition of electrical science. Indeed, one would have expected the demand for perfect insulation to come rather from one of the modern school of *soi-disant* electrical engineers, or other tyro in electric science, than from the collective wisdom of the telegraphists. Another illustration of the loose, inconsequent manner in which these rules are put together, and of the vagueness of the language used, is afforded by the requisition that the dynamo "should be kept perfectly clean." Cleanliness, like insulation, is only relative in respect to such a matter as this, the ideal of perfect cleanliness being unattainable, even by the chemist, when working with simple and easily disponable objects. In actual practice, we universally find that when a course so theoretically perfect as to be impossible is ordered or enjoined, that both law and lawgiver soon become to be despised.

It will be found that the telegraphists are remarkably vague with respect to the important subject of coverings for conducting wires, their instructions being merely to the effect that the conductors "should be sufficiently insulated," or "should be protected by suitable additional covering," no particulars whatever being given as to how wires should be guarded when damp is likely to have access, or when passing through walls or partitions. Notwithstanding this notable omission, we find special caution as to the need of fixing the dynamo in a dry place, and where it will not be exposed to a rain of flying particles or dust; points so obvious as to suggest themselves to anyone possessing even a small proportion—say ten per cent.—of the average intelligence.

As might be expected, from the careless way in which the whole code is drawn up, we find several contradictory paragraphs. We are told in one place, that if wires become perceptibly warm, it is a proof that they are too small for the work, and that they ought to be replaced by larger wires, while a previous statement is to the effect that above 150° is the temperature to be avoided.

The fire-risk rules issued by the telegraphists form the sixth tolerably comprehensive code hitherto published, and they are certainly much less clear and pertinent than any one of the preceding codes; this being true, not only as regards subject matter, bu also as regards language. These failures appear however, to arise principally from undue haste in the production of the rules.

When my paper on the subject of the "Fire Risks of Electric Lighting" was communicated to the Society of Arts, I regarded Mr. Heaphy's set of rules as being the best; and I supplemented them by nine suggestions, it being intended that these should be considered in formulating a more comprehensive code. It is curious to note that the telegraphists have embodied several of my suggestions in their rules, but only after having well turned them round about, so as to give them some appearance of originality. My suggestion, that no part of the conducting wires should be allowed to come within one-fourth of an inch of any metallic body, excepting when such metallic body forms some essential part of the electrical apparatus, finds a clumsy and partial expresssion in rule 19 of the telegraphists, where we find it ordained that "the lanterns and all parts which are to be handled should be insulated from the circuit;" while my requirement, that no conducting wire is to be allowed to come within half an inch of any metallic body having direct electrical connexion with the earth, finds an equally partial and incomplete exposition in the telegraphists' suggestion, that the dynamo should be fixed on an insulating bed.

One point on which I most strongly insisted is the importance of not only soldering the joints of the electric conductors, but also of properly binding them. This matter is evidently regarded by the telegraphists as being of considerable importance, as they give a diagram illustrative of a method of making a joint according to these principles; but the joint illustrated is unstructural and defective to a high degree. The strain comes on opposite sides of the binding spiral so as to tend to rack the spires into an oblique position with regard to the main wires, and so tend to break the soldered joint. If, however, the ends of the main wire are turned over a little more sharply than represented in the telegraphists' diagram, and in making the joint, the turned over ends are made to correspond as nearly as possible with the same longitudinal line, compression of the spiral takes the place of racking strain. To place the purlins and pole-plates of a roof over the rafters would be quite a comparable proceeding to making a lead joint as suggested by the telegraphists. (The mode of making a joint which is here deprecated for electric light leads, is very fairly well suited for ordinary telegraph work, solder not being essential, and there being, therefore, no objection to a racking of the spires of binding wire.)

The best way to make an electrical joint is, first to thoroughly tin the wires, and then wipe them carefully while they are still hot; any chloride of zinc which may have been used being next removed by a damp cloth. The wires are then bound, and subsequently well grouted with solder; resin only being used as a flux.

One valuable suggestion, which does not appear to have been embodied in any other code, may be found in the rules of the telegraphists, as we find them strongly insisting that "The chief element of safety is the employment of skilled and experienced electricians to supervise the work."

The need of a thoroughly comprehensive and clear set of rules is now more patent than ever, and this can only be arrived at by a conference, which should comprise not only men who have received a systematic scientific training, but also practical electricians, expert technologists, and specialists as regards insurance risks.

THOMAS BOLAS.

Chemical and Physical Laboratories,
Chiswick, W., July 11th, 1882.

General Notes.

INSTITUTION OF MECHANICAL ENGINEERS.—The Summer Meeting of this Institution will be held at Leeds, from Tuesday, 15th, to Friday, 18th August.

AMSTERDAM INTERNATIONAL, COLONIAL AND EXPORT EXHIBITION.—At the request of the Ambassador for the Netherlands, and the Executive Committee, the Lord Mayor has appointed Mr. P. Simmonds British Commissioner for the Exhibition to be held at Amsterdam next year. Mr. Simmonds filled a similar appointment for the Amsterdam International Exhibition, in 1869. The offices of the British Commission are at 35, Queen Victoria-street, E.C.

A DOMESTIC EXHIBITION, which will include scientific apparatus, and domestic appliances grouped under the headings of the dwelling, foods, clothing, and water-supply, is fixed to be held at the Alexandra Palace, during the autumn of the present year. It is announced that steps are being taken by a committee for the purpose of holding a Conference on Domestic Economy in connection with the Exhibition.

SEPARATION OF GOLD FROM SAND.—An apparatus for separating gold from sand has been recently devised for use in the placer regions of the West Mexico and Central America, where gold-bearing sands are found at too great a distance from water to make hydraulic mining profitable. The machine is about five feet in diameter, and is arranged to throw the sand by centrifugal force against a "wall" of mercury, maintained in position by centrifugal action. In this way, it is claimed, every particle of gold is brought into contact with the mercury, and thus amalgamated, while the sand is blown away by means of an air blast. The machine is said to treat a ton of sand in twenty minutes, and to be so certain in its operation, as to make it possible to wash over, with profit, the tailings of mines worked by other systems.

OYSTER CULTURE IN ITALY.—The problem of obtaining a cheap supply of oysters appears to have been solved by the Italians. The most extensive ground of all, and that from which most of the oysters consumed in Southern Italy are obtained, is known as the "Mare Piccolo" or little sea, near Taranta. An immense number are reared here, and the consumption of the produce of these beds is estimated to average seven to eight millions annually, the price ranging from three to six lire per 100. The system of cultivation appears to be as successful as it is simple. From April to November, bundles of brushwood are submerged in the outer sea, and to these the spawn is found to readily attach itself. They are afterwards raised, and those on which the tiny oysters have settled are sunk in the Mare Piccolo, where, in about two years, they attain their full size.

Journal of the Society of Arts.

No. 1,550. Vol. XXX.

FRIDAY, AUGUST 4, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

SOCIETY OF ARTS EXAMINATIONS.

The Programme for 1883 will be issued shortly, and an abstract of its contents will appear in a later number of the *Journal.*

The following tables will show the result of the various Examinations of the Society held during the year 1882:—

Subjects of Examination.	Number of Papers worked.	1st Class Certificates awarded.	2nd Class Certificates awarded.	Not passed.
Commercial Examinations:—				
Arithmetic	70	7	26	37
Book-keeping	39	10	21	8
Commercial History and Geography	..	..	..	..
English	37	7	23	7
French	17	3	6	8
German	5	3	2	..
Italian	..	..	..	..
Shorthand	27	2	2	23
Spanish	..	..	..	..
Domestic Economy:—				
Clothing	75	23	47	5
Cookery	66	17	27	22
Laws of Health	47	7	23	17
Housekeeping and Thrift	16	3	9	4
Political Economy	28	8	10	10
Theory of Music	268	40	124	104
Totals	695	130	320	245

Practical Examinations in Music.

Centres of Examination.	No. of Candidates examined.	No. passed.	1st Class Certificates.	2nd Class Certificates.	Honours.	
					1st Class.	2nd Class.
Society of Arts, London (January)	74	60	31	39	..	..
,, ,, ,, (July)	177	152	75	102	..	1
Glasgow Association for Higher Education of Women (May)	77	61	28	35	..	..
Liverpool (Convent of Nôtre Dame) (May)	39	37	23	26	..	..
Birmingham and Midland Institute (July)	22	10	6	8	..	..
Totals	389	320	163	210	..	1

POTTERY EXHIBITION.

In the spring of the present year, the Council of the Society of Arts decided to follow up the highly successful Photographic Exhibition, by arranging a select Exhibition of Modern English Pottery. The space available for the purpose being small, the Council were unable to avail themselves of several offers which were made to them of objects for exhibition; but those which were exhibited were of a highly representative character, and showed very markedly the progress that has been made of late years in the various departments of pottery manufacture — porcelain, stoneware, and earthenware, all being fully represented.

The Society of Arts has always been interested in the progress of British pottery, and various premiums were offered for improvements in the manufacture at the first formation of the Society, in the middle of the last century. At this time there was considerable activity among the potters. In 1744, Edward Heylyn, of Bow, and Thomas Frye, of West Ham, obtained a patent for the production of a ware equal to, if not exceeding in goodness and beauty, china or porcelain ware imported from abroad. The material used is described as "an earth, the produce of the Cherokee nation, in America, called by the natives unaker." In 1768, William Cookworthy took out a patent for a hard porcelain invented by him; and in the following year Josiah Wedgwood obtained a patent for "ornamenting earthen and porcelain ware." Before the date of that of Heylyn and Frye, only twelve pottery patents are recorded; the first is dated 1626, by which the sole making of the stone pottes, stone jugges, and stone bottelles was granted to Thomas Rous, *alias* Rius, and Abraham Cullin for a term of fourteen years

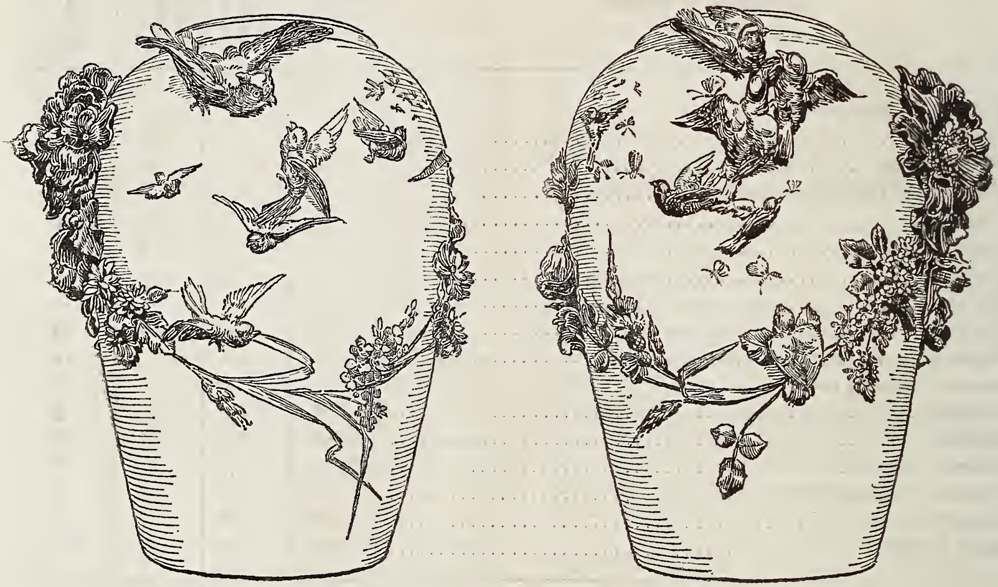


FIG. 1

FIG. 2.

VASES BY BROWN-WESTHEAD, MOORE & CO.

In the session 1819-20, the Society of Arts offered a premium for the discovery of the cheapest, safest, most valuable, and most easily fusible composition for the purpose of glazing earthenware, without any preparation of lead, arsenic, or other pernicious ingredients, and superior to any hitherto in use; and in 1820 the Isis gold medal was awarded to Mr. John Rose, of Coalport, Shropshire, for an improved glaze for porcelain. Mr. Rose was the founder of the famous Coalbrookdale, or Coalport works. Soon after this award, a large gold medal was given by the Society to Mr. J. Meigh, of Shelton, Staffordshire, for a glaze for vessels of common red earthenware.

The names of the seven firms whose productions formed the present Pottery Exhibition are here given in alphabetical order :—

Messrs. T. C. Brown-Westhead, Moore & Co., Staffordshire.

Messrs. Henry Doulton & Co., Lambeth Potteries, and Potteries, Burslem, Staffordshire.

Mr. John Harrison, Linthorpe Pottery, Middlesbrough-on-Tees.

Messrs. Maw & Co., Benthall Works, Broseley, Shropshire.

Messrs. Mintons, Stoke-on-Trent.

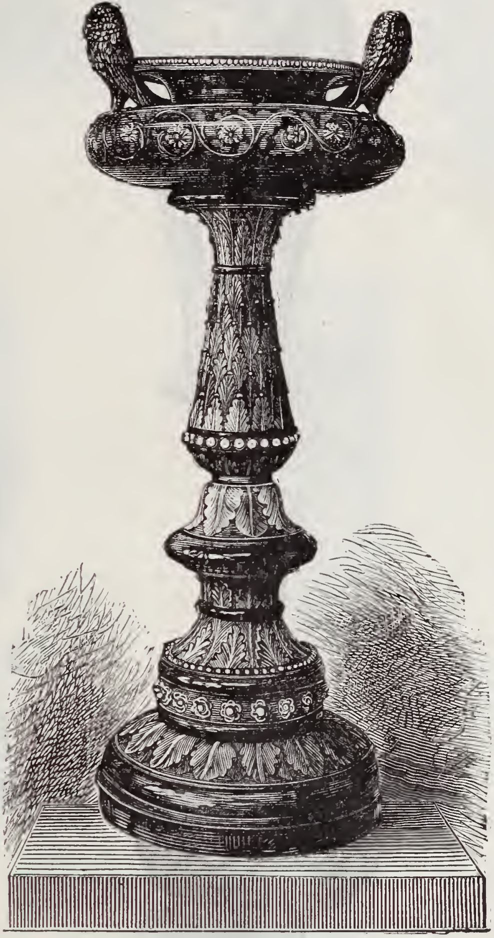
Messrs. Josiah Wedgwood & Sons, Etruria, Stoke-upon-Trent; and

The Worcester Royal Porcelain Company, Worcester.

The various exhibits were so arranged that some of the choicest objects could be placed in the glass cases round the room. The large able in the window, at the end of the room, was occupied by Messrs. Mintons. Messrs. Doulton filled the centre table and the stands by the door. The Wedgwood exhibit was on the east side, and the west side contained the Worcester Company's display and the collection of Linthorpe Ware.

The Exhibition was opened on Wednesday, the 24th May, and remained open until Saturday, 1st of July. During this period it was visited by a large number of members and their friends, and by others interested in English pottery. The number of visitors was over twelve hundred.

Fig. 3.



Doulton ware.

Messrs. Brown-Westhead, Moore and Co. exhibited two large vases of a fine ivory colour, upon which were grouped raised birds and flowers in gold and silver, of a remarkably realistic character. These vases are shown in Figs. 1 and 2. Besides these, Messrs. Brown-Westhead showed two oval plaques, with raised birds and flowers, but here the decoration was of the same ivory colour as the ground-work, and not with a metallic ornamentation, as in the case of the vases.

Messrs. Doulton had three distinct exhibits. On the centre table were various kinds of Doulton ware, and on one side of the entrance was a collection of Lambeth Faïence and Impasto ware. On the other side, a collection of earthenware, made at Burslem, Staffordshire.

Messrs. Doulton exhibited some decorated pottery at the International Exhibition at South Kensington, in 1870, but it was not until 1871 that Miss Barlow, the first lady artist, was employed permanently as a decorator of stoneware. At the present time there are about 230 ladies engaged in the art departments of the works. On April 29th, 1874, Mr. Sparkes read a paper before the Society of Arts on some recent inventions and applications of Lambeth stoneware, terra-cotta, and other pottery for internal and external decorations. (See *Journal*, vol. xxii., p. 557.) Six years later, Mr. Sparkes read another paper before the Society, in which he gave an account of the further development of the Lambeth pottery. (See *Journal*, vol. xxviii., p. 344.) These papers, besides a description of the processes, contain information respecting marks used by the artists.

In the Hall were two large vases of Doulton ware on pedestals, standing altogether about six feet in height. These were ornamented with incised animal groups, designed by Miss H. B. Barlow. There was also a large bowl and an elevated stand similar to that shown in Fig. 3.

The collection of Doulton ware may be divided under the following three heads :—.1 Salt-glazed decorated stoneware; 2. Salt-glazed *pâte sur pâte*; 3. Silicon ware. The whole of these wares are subject to one firing only, and are fired in the open kiln.

There is very great variety in the first class, as will be seen from some of the illustrations here given. The decoration consists entirely of original designs, and, except in the case of pairs, no two objects are exactly alike. It is of incised, modelled, and applied work, and the treatment is both natural and conventional. The forms are also very varied, and vases, jugs, cups, and candelabra in many shapes were represented. Besides these, there were some small square panels in colours, with figure subjects illustrating fables, modelled by Mr. George Tinworth.

Fig. 4.

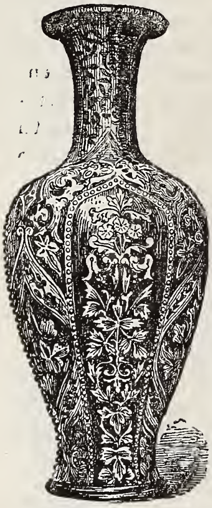


Fig. 5.

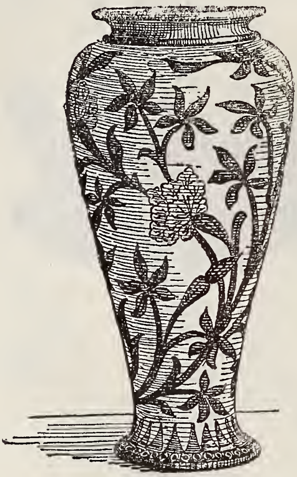


Fig. 6.

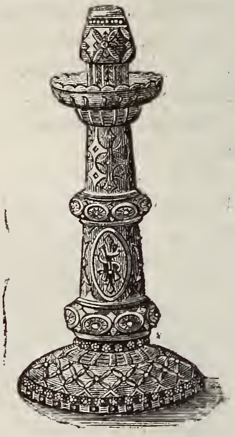


Fig. 9.

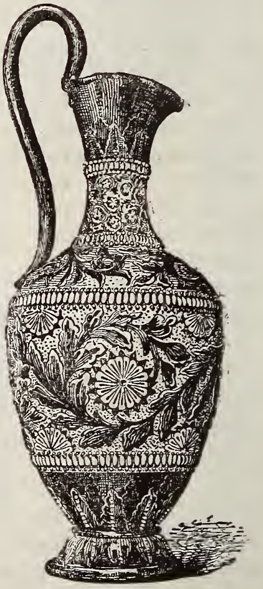


Fig. 7.

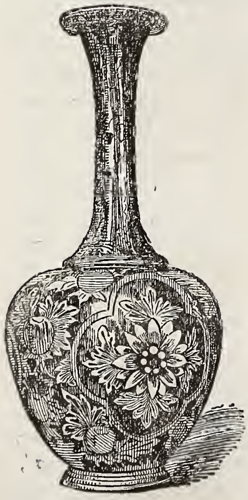
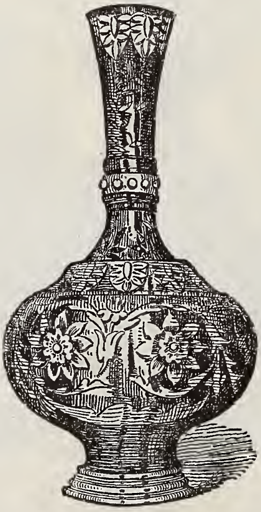


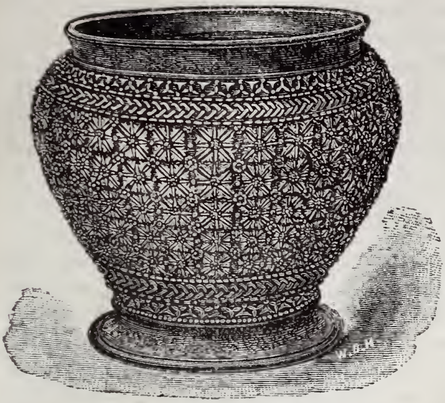
Fig. 8.



Doulton Ware and Lambeth Faience.

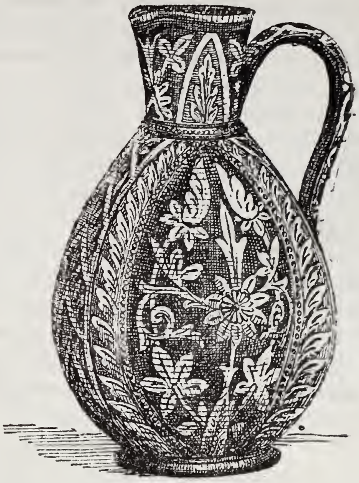
In the second class, there were some specimens of *pâte sur pâte*, in which the decoration is produced by coloured clays or slips laid on, and modelled with the brush.

FIG. 10.



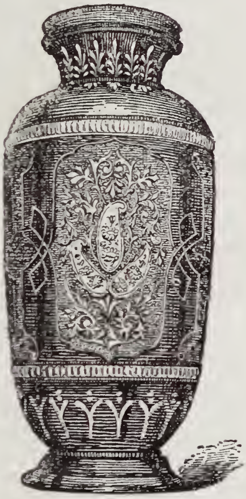
DOULTON'S SILICON WARE.

FIG. 11.



DOULTON WARE.

FIG. 12.



DOULTON'S SILICON WARE.

FIG. 13.

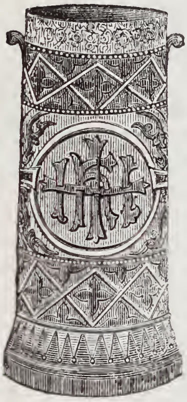
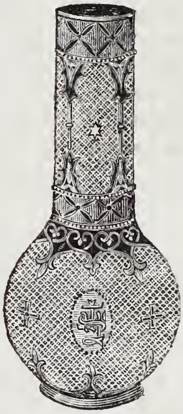
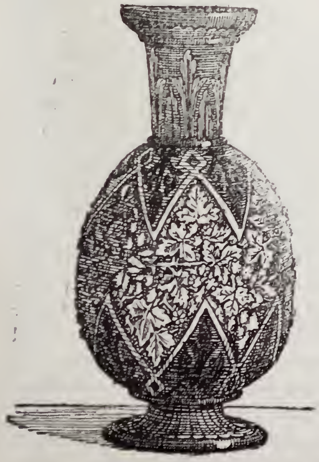


FIG. 14.



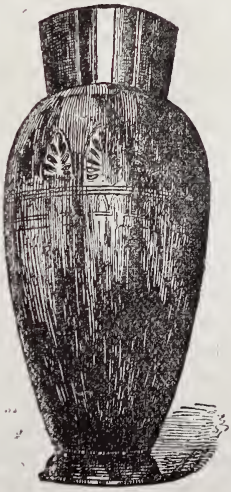
DOULTON WARE.

FIG. 15.



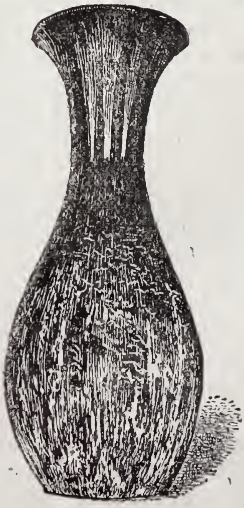
DOULTON WARE.

FIG. 16.



LINTHORPE WARE.

FIG. 17.



LINTHORPE WARE.

It is in fact painting on the solid body with an earthy pigment. These will be seen in Figs. 4 and 9, but of course the colouring, which forms so important a part of the ornamentation, can only be guessed at.

The third class, or silicon ware, is a new manufacture of considerable hardness. In the earlier specimens, the silicon ground is elaborately covered with a bluish applied work of simple design, as in Fig. 10, but a much more delicate result has now been obtained by the application of a *pâte sur pâte* decoration. Fig. 12 represents one of these beautiful vases. On the centre table there were also some terra-cotta panels with sketches of scriptural subjects, in high relief, modelled by Mr. George Tinworth.

The collection of Lambeth Faïence and Impasto ware consisted of vases, jugs, plaques, tiles, &c. The Faïence is decorated in underglaze, with conventional ornaments, consisting of fruit and flowers. The forms and general tone of these vases has much of an Italian character, and some of the designs are not unlike what may be seen upon the vases and jugs in the pictures of the old Italian masters. A great range of effect is obtained by the use of many colours. Persian and Rhodian designs have been freely imitated. In some cases the objects have an over glaze finishing. Figs. 7 and 8 are specimens of Lambeth Faïence.

The Impasto ware is of lightish brown ground-work, with floral decoration added in coloured slips; this is burnt in under-glaze kilns. The colour is applied thickly to the raw clay, and the artist needs a good knowledge of the laws of light and shade, as the thickened vehicle he uses effects the form as well as the colouring.

The collection of Earthenware contained some large pieces, elaborately ornamented with highly raised coloured shells, richly moulded, and others with raised flowers, in place of the conchoid decoration. Besides these, there were vases, jugs, plates, and plaques with under-glazed painted work, the bodies being of celadon and other colours, remarkable for their likeness to porcelain. A fine covered vase, which occupied a centre position, was decorated in the Japanese taste.

The large display of specimens of Linthorpe ware in vases, tazzas, flower-pots, card trays, fruit dishes, &c. must now be noticed. These are varied in shape and tone of colour, but all have a rich glaze. The ornamentation is but slightly marked on the surface, and is chiefly obtained by shades of colour. There were, however, some plaques with a rough ground, on which were raised flowers. Linthorpe is a suburb of Middlesbrough-on-Tees, and the pottery was started on his estate at that place by Mr. Harrison a few years ago, chiefly on the suggestion of Dr. Dresser. The material is a common red brick clay, and the artistic effects are chiefly obtained from the originality of forms and from the parti-coloured glazes. Some of the shapes have been derived from Egyptian, Moorish, Indian, Chinese, Japanese, and other examples. Considerable picturesqueness may be perceived in the form of the handles of some of the objects. Low-toned reds, mottled olives, browns and yellows, are found in great variety. An attempt has also been made to reproduce the highly-prized *Sang-de-Bœuf*. Where so much depends upon colour, it is not easy to reproduce the effect in black and white, but Figs. 16 and 17 will give some idea of two of the vases exhibited by Mr. Harrison.

It is proposed to give an account of the other exhibits, with illustrations of Wedgwood ware and Worcester porcelain, in a subsequent number.

IRRIGATION IN EGYPT.

The American Consul-General at Cairo, states that the tillable land of Egypt consists of the delta of the Nile, and a narrow valley extending from Cairo, southward. This valley is generally from one to ten miles wide, though for about 150 miles above Cairo it has a width of from ten to thirty miles. Both the delta and the valley, except so far as the former borders on the Mediterranean, are bounded on all sides by mountainous deserts, and for more than 2,000 miles from its mouth the river has not the smallest tributary. It rolls on towards the sea, unlike other rivers, constantly decreasing in volume. As there are no rains of any practical importance, it sustains all vegetation, and all the inhabitants of Egypt and its herds drink of its waters. For two or three months in the year, a considerable portion of the country may be irrigated by the natural rise of the river, but with the exception of certain sections, the water is not permitted to flow freely over the land. It is taken from the river and conducted by canals alongside the fields where it is to be used, and spread over the different parcels of land, if it is sufficiently high, and if not, it is raised by some of the various modes employed for that purpose. Small embankments prevent the water from running on to other lands that may not at the time be in a condition to receive it; in fact, the processes of overflowing the lands, ploughing, sowing, and harvesting are often being carried on simultaneously in adjoining fields. When the land is sufficiently irrigated, the water is shut off, or the pumping discontinued. The process of irrigation is required to be repeated several times before the maturity of the crop, the quantity of the water depending very much upon the kind of product. Rice requires a large amount of water, and wheat, rye, and oats, much less. There are in Egypt 8,406 miles of irrigating canals, of which 1,897 are navigable. There are also great dykes along the river and its various delta branches, to prevent their overflow, and innumerable small ditches and embankments everywhere throughout the country. In consequence of the muddiness of the waters of the Nile, the canals require frequent cleansing, and the high waters injure the dykes and render it necessary to repair them each year. The greatest amount of labour is, however, that required in raising the water from the river and canals to the level of the lands. Dipping, drawing, and pumping are processes going on nearly the whole year, and nearly half of the whole irrigation is done by these means. Its water is raised from one or two feet to twenty, and sometimes more, according to the location of the land and the height of the river. The following is a description of the manner in which water is raised by means of the "shadoof." The "shadoof" is simply a leather basket-shaped bucket attached to a pole, suspended in the same manner as an ordinary well-sweep. The sweep is very short, and the bucket of water is balanced by a mud weight. The instrument is of the rudest character, but by this means water is raised to the height of eight or nine feet with considerable rapidity. If the water is to be raised twenty feet, one man close to the river raises it from four or five feet into a basin made of clay in the side of the bank, and from this point two men, each with a bucket, raise it about eight feet to a similar basin, and two other in the same manner to the required height, whence it is conducted by small earth sluices to the required place, often a considerable distance from the river. It requires the constant working of these five "shadoofs" for forty-eight hours to water one "feddan" (equivalent to one acre). This, by changing once in four or six hours, would require ten men, each of whom would apply twenty-four hours' labour to the watering of one acre. This process requires repeating at least three times for each crop. Thus the labour required for the irrigation of one acre would be 720 hours, or seventy-two days of ten hours each. The labour is of the most severe kind, and the fellah, with nothing except a cloth round his loins, is compelled to apply himself to his task with all the energy at his command. In the delta, and some parts of Upper Egypt, the water being taken from the river at some distance above the point where it is used, is kept for a considerable portion of the year, on very nearly the same level as the land. If, however, it has to be raised at all, it requires at least fifteen days to the acre. When the water is raised only a few feet, the more ordinary method is that of the "sakia," a rude machine propelled by oxen, cows, and horses, and sometimes camels and donkeys, and which raises the water by means of earthen jars attached to an endless rope-chain passing over a vertical wheel. There are a few steam-pumps, but fuel is too expensive, and labour too cheap to permit of their general use. The number employed is about 400, and these are mostly in Lower Egypt. They are used principally on large estates, but in some cases by those who irrigate the lands of the small farmers, at a fixed price per acre. This is generally where cotton is produced, which requires watering once in eight or ten days throughout the season. The water has ordinarily to be raised but a few feet, and the quantity required each time, when the watering is so frequent, is much less. The usual price paid per acre is about 30s., and it is only the low price of farm labour that renders it practicable to cultivate lands requiring so much irrigation.

THE CULTIVATION OF COFFEE IN LIBERIA.

In Liberia the coffee tree is grown in all varieties of soil, and prospers most in those of a loose nature, such as the sandy and loamy soils, especially if these are strengthened by the addition of rocks. There are two species of sandy soil in Liberia; one has been the bed of the sea, and this has not been enriched by decayed vegetable matter, its substratum of clay or other earth, is at too great a depth to be of service to it, and hence, it is barren, or nearly so. The other sandy soil has been somewhat enriched by decayed vegetable and other matter, and has near the surface a substratum of clay. This serves as a reservoir, to hold the surplus water, which, rising through the sand by capillary attraction, keeps plants growing, even in dry weather. This soil is particularly suited to coffee, which grows rapidly in it. The United States Consul at Monrovia says that the method of cultivation practised in Liberia is similar to that adopted in the East Indies. The forests are cleared in the same manner; the undergrowth is first cut, then the large trees are felled, lopped, and when sufficiently dry, the whole is set on fire. The stumps of the trees are, as a rule, immediately removed. The entire ground is not ploughed, but holes are dug at proper intervals for the reception of the plants. These are generally not less than 12 feet apart, and are dug in straight parallel lines. Ploughing, by loosening the soil, would, on sloping land, render it liable to be washed away by the heavy rains. The plants are taken from the nursery when from a year to two years old, and in planting, the cherry hull is removed, and the seeds are deposited in rows from two to three feet apart. The seeds are inserted in the ground at a depth of about one inch, if the showers be regular, but at a depth of two inches if the weather is dry. The transplanting is generally done at the beginning of the rainy season, in May or June. The trees are topped at the height of five feet, but this rule is not observed by all farmers. After the trees are topped, they shoot out a number of suckers from the trunk; these are generally pulled out by hand, and no secondary shoots are allowed to grow on the branches nearer to the trunk than 18 inches. This would give an open space of 3 feet in diameter, in the centre of the tree, for the penetration of sunshine, and the circulation of air. The Liberian coffee tree does not produce all its flowers at one blooming; the time of blossoming depends upon the occasional showers that fall in the dry season, for although the buds may stand out prominently, they will remain without opening for a space of two months, or until there falls a shower of rain sufficient to saturate the soil; a light shower which does not soak into the ground will not cause them to open. In December, a slight blossom appears, and the fullest blooms occur in January and February. There is only one full crop, and this is gathered during the months of December, January, February, and March. Surface manuring is the best suited to Liberia coffee trees, as these belong to the class of forest trees whose feeders keep near the surface. Even when the manure is placed in trenches, the fibrous roots or feeders penetrate it and seek the surface long before the manure is consumed. Coffee pulp, mixed with other ingredients, guano, ashes, and clay from the hills of the "Termites" are also extensively used as manures to promote the growth of the coffee tree. Two systems of hulling the coffee are practised in Liberia; one consists in taking off the cherry hull when fresh from the tree, drying the bean, and then denuding it of its parchment hull; the other in drying the entire berry, and taking off both hulls by one manipulation. The former method is the more expeditious, but by the latter there is an improvement in the quality of the coffee, as the beans having been thoroughly dried in both hulls, the aroma is prevented from escaping, and it is also said that there is a gain in the weight of the bean. The Liberian coffee tree is not subject to so many diseases as is that of other countries; there are, however, sometimes observable on the leaves of some trees, small yellow spots, which, in the opinion of many Ceylon planters, was the *Hemeloia vastatrix*, that pestilence so destructive to coffee plantations in the East Indies. But these spots were found always of the same colour, and did not turn black, nor did the leaves drop off, as in the case of the above-named disease, and the trees bore their usual quantity of fruit. The borer only occasionally attacks the coffee tree in Liberia; this is the larva of a fly or winged beetle, now identified as the *Xylotrechus quadrupes*. It generally attacks the tree some inches above the ground by boring. There is a disease also which affects the bark of the coffee tree, and this is caused by grubs attacking the roots of the tree. The disease, however, does not always begin at the root; sometimes it appears in one of the branches, at others it is to be found in a long line on one side of the tree, while the bark in all other directions is perfectly sound and healthy. In no case, however, where diseases similar to those in other countries attack the Liberian coffee tree, are the effects so general or so disastrous. Different estimates have been given of the production of the Liberian coffee trees. It has been stated that, if properly cultivated, they ought to average three pounds when ten or twelve years old, but the trees, owing to lack of means to give them the high cultivation which they require, do not produce on an average one third of the quantity they are capable of producing. Consul Smyth states that a Ceylon coffee planter of thirty years' experience in coffee growing, estimated that the production of an acre of Liberian coffee would, under favourable circumstances, equal that of ten acres of Ceylon coffee. The cost of cultivation per acre may be roughly estimated as follows:—Clearing the land, £2; cost of plants, 24s., planting, 13s. Weeding, the first year, if the ground is thoroughly cleared and burned at first, will be only half the cost of subsequent years. The cost of weeding, after the first year, may be estimated at 22s. an acre, when weeding is done after the Liberian method generally, that is two weedings a-year. There will be no cost for topping or pruning the first year; about the third year, however, after the trees are planted, there will be an expense of about 6s. an acre for topping, and in subsequent years the cost of pruning, amounting to about 6s., must be added to this. The expense of tools, machinery, or superintendence, is not included in the above estimates. Consul Smyth, in conclusion, states that the Liberian coffee industry is attaining very considerable importance, and the quantity exported, largely increasing every year.

Correspondence.

TREATMENT OF FIBRES.

Having observed the remarks made by Mr. Thomas Christy respecting Mr. Ekman's "process for the treatment of different fibres," printed in your *Journal*, No. 1,543, Vol. xxx., dated the 16th June, 1882, I take the liberty to call to your attention my patents, No. 4,419, and No. 5,532, for the "production of solvents and manufacture of pulp," and believe that any kind of fibre can be properly dissolved by my process in a cheap and practical way. I use my invention principally for wood and straw, at my mills at this address (about three miles from Gothenburg), but I find also its practicability and excellent effects on jute and esparto, and would have no objection to making experiments with any other kind of fibre, such as rhea, if some one interested in this process would communicate with me, and furnish the necessary quantity of material.

D. O. FRANCKE.

Korndal Mölndal, Sweden.

TRADE AND COMMERCE OF SMYRNA.

Of all the administrative reforms introduced in this country, statistics still remain a *terra incognita*; therefore, one must necessarily enter upon such subjects with diffidence; however inaccurate the data upon any given subject may be, they may yet help, at all events, to form a proximate idea of control. I am indebted for much of this information to H.B.M's Consulate at this place.

TABLE I.—THE FOLLOWING ARE THE APPROXIMATE GROSS AMOUNTS OF THE GENERAL FOREIGN TRADE AT THIS PORT FOR THE FIVE YEARS ENDING 31ST DECEMBER, 1881 :—

Year.	Imports from all foreign countries	Exports to all foreign countries.	Total annual amounts.
	£	£	£
1877..........	3,082,320	4,682,000	7,764,420
1878..........	4,139,900	3,504,600	7,680,500
1879..........	4,686,100	4,406,700	9,092,800
1880..........	3,980,410	3,852,480	7,832,890
1881..........	4,656,000	3,803,600	8,459,600
Total amounts for the 5 years.	20,544,830	20,285,380	40,570,210

As compared with 1875 and 1876, when the amounts were respectively—

	1875.		1876.
	£		£
Imports......	2,260,000	......	2,860,000
Exports......	3,930,000	......	4,630,000
	6,190,000		7,490,000

The balance of trade went against Turkey, the imports augmented and the exports declined; at the same time the general amount of trade made but little progress. This is owing partly to the destruction of the crops by locusts, which ravaged this province for the last six years, and partly to the number of agricultural hands drafted in the army.

TABLE II.—GROSS AMOUNT OF THE TOTAL BRITISH TRADE AT THIS PORT FOR THE FIVE YEARS ENDING 31ST DECEMBER, 1881 :—

Year.	Imports from the United Kingdom.	Exports to the United Kingdom.	Total annual amounts.
	£	£	£
1877..........	1,244,730	1,996,400	3,241,130
1878..........	1,742,810	1,525,710	3,268,520
1879..........	1,531,800	1,998,800	3,530,600
1880..........	1,180,700	1,610,800	2,791,500
1881..........	1,626,300	2,393,740	4,020,040
Total amounts for the 5 years.	7,326,340	9,525,450	16,851,790

One noteworthy point to be observed in this last table is that England actually is the largest and best customer of Turkey. While the gross value of the last five years' imports from the United Kingdom amounted to £7,326,340, the exports to the United Kingdom amounted to £9,525,450; thus the balance of the British trade was in favour of Turkey by £2,199,110, or nearly 24 per cent. On the other hand, the imports from all other foreign countries amounted to £13,218,490, and the exports were only £10,759,930, so that the balance of trade stands against Turkey by £2,458,560, or nearly 20 per cent.

According to official data the following amounts are encashed by the Custom-house at Smyrna, on the foreign import and export trade, for the three years ending 13th March, 1882. (The Turkish financial year commences every 1st of March, old style):—1879-80, 19,468,692 piastres; 1880-81, 14,707,205 piastres; 1881-82, 19,934,050 piastres. (117 piastres is equal to one pound sterling,)

It must be born in mind that these sums do not represent even approximately the amount of dues which ought to be levied on the imports and exports; extensive smuggling is going on in and out of the Custom-house.

An extensive coasting trade is being carried on between this port, Constantinople, the Archipelago, the coast of Caramania, and Syria. No reliable data can be obtained, still, the amount of this traffic cannot be calculated at less than 25 per cent. of the total foreign trade, or say £2,000,000 a year, we thus get an aggregate gross annual sum of the Smyrna trade of £10,500,000, or thereabout.

Although some of the articles of export have been declining of late years, such as cotton and cereals, yet the fruit trade has taken a great development with enhanced prices, particularly the common black raisin, so extensively exported to France for the manufacture of wine. No wonder that the vineyards of this province have attracted the attention of German capitalists, who have sent here a special agent to study that branch of the industry on the spot, and with a view at first to the making of wine for export on a large scale from the native grapes, but later on to plant extensive tracts of land with the finer classes of vine. At present, the land under vineyard cultivation in this province is calculated to be over one million dunoums (about 350,000 acres); this extent is being augmented annually.

The export of figs, too, has greatly increased; last year's crop was the largest ever known; it is computed that about 13,500 tons have been exported from this port. Among other articles of export, opium, valonnea, and liquorice roots, go on increasing annually. There has also been a very brisk business in the export of Turkey carpets, mostly to England.

In conclusion, with an effective police to guarantee personal security, and the further extension in the interior of our two railway lines, the trade of Smyrna would double within a few years.

S. STAB.

Smyrna, 8th June, 1882. Cor. Mem. Society of Arts.

Notes on Books.

THE HALL-MARKING OF JEWELLERY PRACTICALLY CONSIDERED. By George E. Gee. London: Crosby Lockwood & Co. 1882.

Mr. Gee, who claims to have considerable experience of his subject, as one of the largest Hall-markers of silver chains in the United Kingdom, has here produced a volume in which he gives an account of all the different assay offices of the United Kingdom, and also some practical suggestions concerning the mixing of alloys. The appendix contains a reprint of the Acts of Parliament relating to Hall-marks, and in one of the chapters, offences against Hall-marking laws and their penalties are dealt with. The author has attempted to supply such information as is required by those interested in the subject, whether as dealers or workers in the precious metals.

THE EDDYSTONE LIGHTHOUSES (NEW AND OLD). An Account of the Building and General Arrangements of the New Tower. By E. Price Edwards; with an abridgment of Smeaton's Narrative of the Building of the Old Tower, by T. Williams. London: Simpkin, Marshall & Co. 1882.

Reports from time to time reached the Trinity-house authorities that the celebrated lighthouse erected by Smeaton on the dangerous Eddystone reef, in 1759, was occasionally subject to tremors and oscillations; and in 1877, a thorough inspection was undertaken, when it was found that the rock upon which the lighthouse stood was being undermined by the action of the waves. Smeaton's tower, itself, showed no signs of decay. Suggestions were made to the authorities that the rock should be blown up, instead of a new lighthouse being built, but it was estimated that no less than two million tons of rock would have to be removed, and that the expense of the work would amount to about seven times the cost of building a new tower, besides occupying an enormous time. The result of the official inspection was, that operations for the construction of a new tower were at once undertaken, and on the 17th July, 1878, the first landing on the rock was made. The new building is considerably larger than Smeaton's tower. It consists of 2,171 stones, containing 63,020 cubic feet, or 4,668 tons of masonry, while Smeaton's building contained only 988 tons of stone. The estimated cost of the building was £78,000, but at present the figures of the exact amount cannot be given. Mr. Price Edwards has written a full account of the operations connected with the building, and Mr. Williams has added an abstract of Smeaton's own narrative of the building of his tower.

General Notes.

HEATHORN'S STEERING APPARATUS.—Captain T. B. Heathorn has made some improvements in his arrangement for steering gear since a notice of his apparatus was printed in this *Journal* (vol xxvii, p. 634). An explanation of Captain Heathorn's new method of checking sternway is given in the number of *Iron* for June 23, 1882 (p. 491):—"The checking is accomplished by a simple alteration of the relation of the curved levers and the carrying levers, so that now each rudder head is not only held firm in every position of the arc of 125° which it traverses, but can govern each rudder to parallel motion with the other one, or act against it in every position with perfect rapidity."

INTERNATIONAL EXHIBITION OF GAS-HEATING APPLIANCES.—In order to popularise the use of gas for heating, the *Association des Gaziers Belges*, acting for the Brussels Municipality, have organised a competitive exhibition of gas stoves for industrial, domestic, and culinary purposes. It is to be held in the Rue Grétry, Brussels, near the Halles Centrales, from 1st August to 1st October. The jury will award gold and silver medals and diplomas, not exceeding, altogether, the value of 4,000 francs. The President of the Committee is M. H. Aerts, manager of the Brussels gas-works.

SAVINGS' BANKS IN ITALY. — The *Banche popolari*, or savings' bank, during the past 12 years, have rapidly developed in Italy, as may be seen from the statistics recently published, from which it appears that there has been a steady increase, both in the number of the banks, and in the amounts deposited.

Year.	No. of banks opened.	Total of deposits. Lire.
1870	50	19,010,385
1871	64	22,388,890
1872	84	26,836,200
1873	88	34,073,760
1874	100	36,808,000
1875	109	36,970,860
1876	111	37,445,610
1877	118	39,050,870
1878	123	40,304,080
1879	133	41,042,610
1880	140	41,494,170
1881	171	44,376,210

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No. 1,551. Vol. XXX.

FRIDAY, AUGUST 11, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

SOCIETY OF ARTS EXAMINATIONS.

PROGRAMME FOR 1883.

The attention of Secretaries of Institutions and others interested in the Society of Arts Examinations is especially drawn to the fact that important alterations have been made in the examination system. The following are the principal points in which changes have been made since the publication of last year's Programme:—

1. The Examinations in subjects of "Commercial Knowledge" have been renewed.

2. The three subjects, "Clothing," "Cookery," "Housekeeping," &c., will be comprised in a single paper, under the head of "Domestic Economy." The examination in "Health," will be continued under the title of "Sanitary Knowledge."

3. A fee of 2s. 6d. will be required from each candidate in each subject.

4. No prizes will be given in any subject.

5. Certificates in *three* classes will be given.

6. The restriction as to the age of the candidates has been removed.

7. An examination will be held in any subject of "Commercial Knowledge," in addition to those already in the Programme, for which 25 candidates offer themselves, provided the Council approve of the subject.

The Council wish it to be understood that the continuance of the Examinations must depend on their practical success, as evidenced by the number of candidates offering themselves for examination; the scheme having been revised in consequence of applications received from certain of the Institutions in Union, it rests with the Institutions to make the Examinations as successful in the future as they have been in the past. It may also be mentioned that the fee charged has been calculated on such a scale as to make the Examinations, as nearly as possible, self-supporting.

SUBJECTS.

The subjects of Examination for 1883 will be—

1. Arithmetic.
2. English (including composition and correspondence, and précis writing).
3. Book-keeping.
4. Commercial Geography and History.
5. Shorthand.
6. French.
7. German.
8. Italian.
9. Spanish.
10. Political Economy.
11. Domestic Economy.
12. Sanitary Knowledge.
13. Theory of Music.
14. Practical Music.

In addition to the above subjects, the Society will provide for an Examination in any other subject which may fairly be comprised in "Commercial Knowledge," and of which the Council approve, provided not less than 25 candidates are guaranteed for such subject.

The Examinations, in all the subjects, except Practical Music, will be held on the evenings of Monday, the 9th, Tuesday, the 10th, and Wednesday, the 11th of April.

ELEMENTARY EXAMINATIONS.

The Society will also supply papers and forms for such Institutions in Union as may desire to conduct an Elementary Examination in Arithmetic, English History, English Geography, English Grammar, and Rudiments of Theory of Music.

The complete Programme will shortly be ready, and can be had upon application to the Secretary.

POTTERY EXHIBITION.

In the notice of the Society of Arts Exhibition of Modern English Pottery, given in last week's number of the *Journal*, account was taken of the exhibits of Messrs. Brown-Westhead, Moore and Co., of Messrs. Henry Doulton and Co., and of Mr. John Harrison. For the present number, therefore, there remain for description the works of Messrs. Maw and Co., Messrs. Minton, Messrs. Wedgwood and Sons, and the Worcester Porcelain Company.

Messrs. Maw and Co., of the Benthall Works, Broseley, Shropshire, exhibited, on a stand near the entrance, a large collection of painted tiles and tile panels, some of them decorated with landscapes, mosaics, and mouldings in coloured clays; also vases, jugs, and tazzas in various coloured glazes. There was one large jar in yellow glaze, and others in splashed green and canary, and in royal blue.

FIG. 1

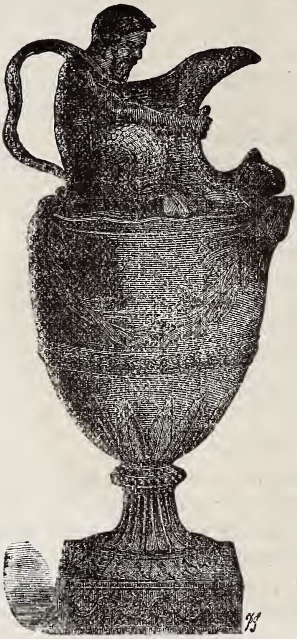


FIG. 2.

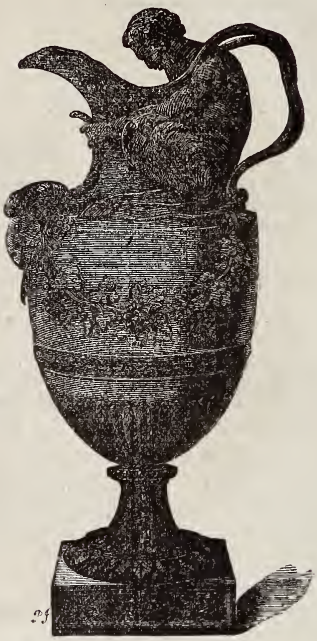


FIG. 3.

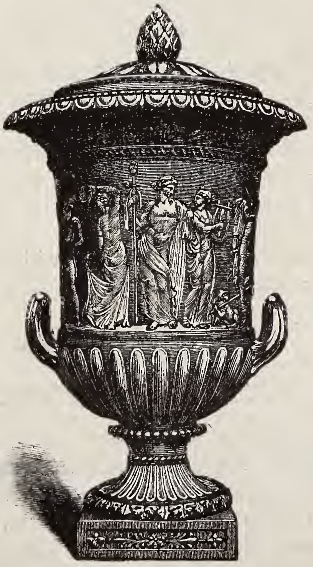
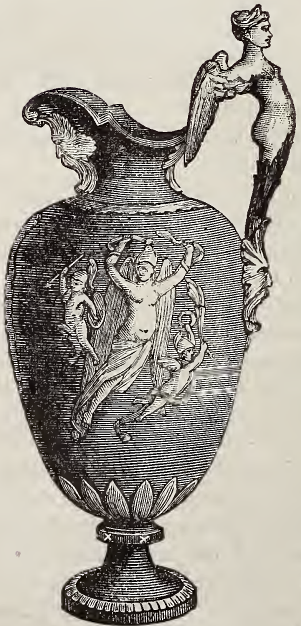


FIG. 4.



WEDGWOOD VASES.

Messrs. Minton, of Stoke-upon-Trent, made a considerable show of a variety of different wares, set out on the window table at the end

FIG. 5.—WEDGWOOD PLAQUE, BY FLAXMAN.

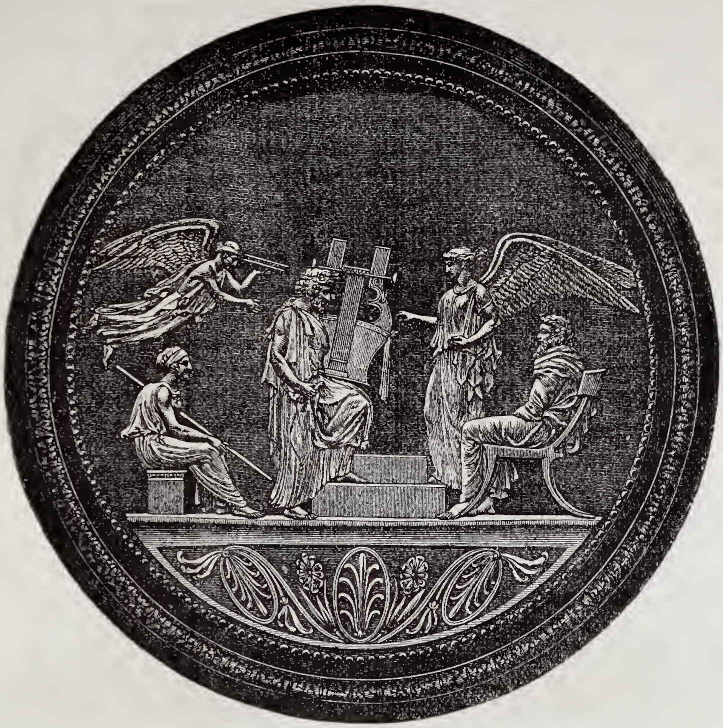
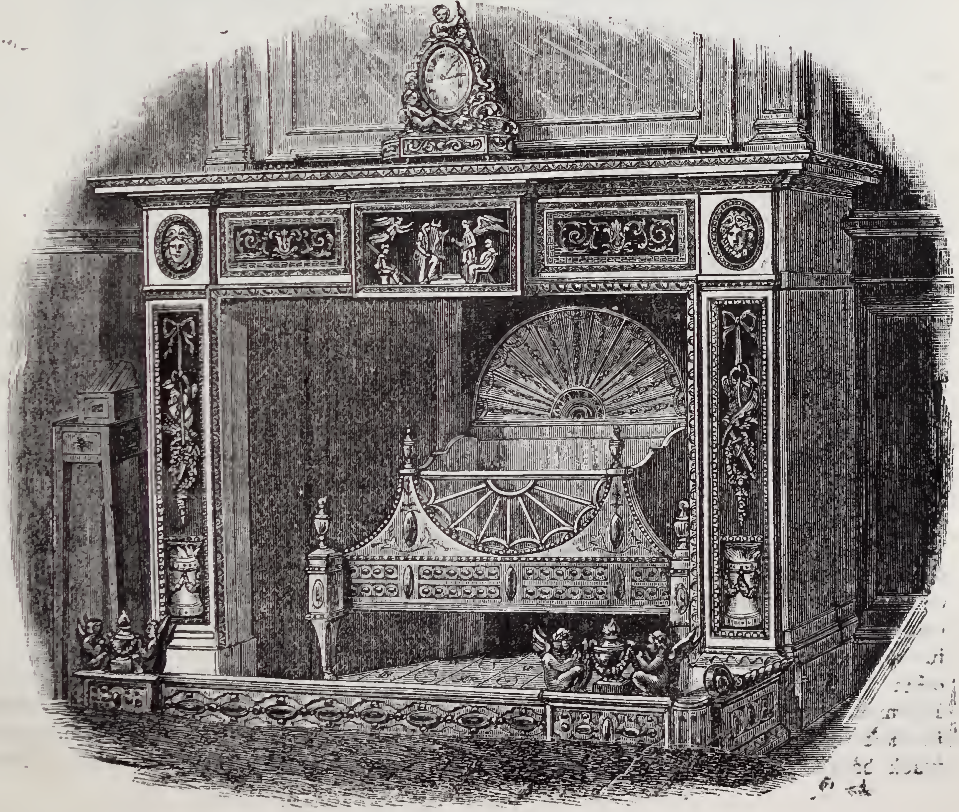


FIG. 6.—CHIMNEY PIECE ORNAMENTED WITH WEDGWOOD PLAQUES.



of the room. There were several tea-sets, vases, plates, trays, plaques, &c. One of the porcelain tea-sets was of open work filled in with a pink glaze. Some of the vases were imitation Sèvres porcelain, and the plaques were richly ornamented with gold. There were several copies of "Henri Deux" ware in various forms; and as well as specimens of *pâte sur pâte* decoration, there were some fine examples of imitation oriental lacquer work. In one of the cases was shown the large Prometheus vase, the body of which was of a beautiful turquoise blue.

Messrs. Josiah Wedgwood and Sons, of Etruria, Stoke-upon-Trent, occupied nearly the whole of the east side of the room, and the objects shown were representative of the historical wares of their firm, and also of those which have been introduced of late years. There were several reproductions of old vases which have made the name of Wedgwood so famous.

Figs. 1 and 2 represent some of the earliest work designed by Flaxman for Josiah Wedgwood. They are the celebrated wine and water vases of black basalt unglazed, which the sculptor modelled about 1776. Another of Flaxman's models is seen in No. 3—a graceful vase, with an original treatment of the handles. It represents Apollo and the Muses in black and white relief, but the vase is sometimes made in pale blue. With the pedestal, this, which stands 19½ inches, is the largest piece made by Messrs. Wedgwood. A black and white jasper vase, known as the "Pegasus," with subject of the Apotheosis of Homer and Virgil, was exhibited on a pedestal. This was a reproduction of an old vase and pedestal, which sold lately at Christie's for 700 guineas. The most famous of Wedgwood's productions was the Portland vase. The original vase was at one time known by the name of Cardinal Barberini, from having been in his possession; but, when it was purchased by the Dowager Duchess of Portland, it took her name. At the sale of the Duchess's property, Wedgwood wished to purchase it, but the Duke of Portland obtained it for £1,029, and lent it to the potter to be copied. Fifty copies were produced, and sold at fifty guineas each, One of these was sold at the poet Rogers' sale for the sum of 127 guineas. The copy here exhibited is one of fifty produced and finished in the same manner as the original. Several other vases from the models and moulds of Flaxman, some in pale blue and white, others in dark blue and white, black and white, and black basalt, &c., were shown. No. 7 is a vase of diced design in chocolate jasper, ornamented with small bas-reliefs. It is one of several used in the decoration of Lord Dysart's mansion at Buckminster. No. 8 shows a large vase, with blue underglaze, which stood on a pedestal between in one of the bays. It is known as the "Swan" vase, from the swans on the stand which supports it. The subjects represented are "David before the Ark," "Delilah and Samson," and "Marianne." The painting was by T. Allen, whose designs are also seen on a pair of Renaissance vases with subject of "Nymphs and Cupids," and a pair of vases painted with "The Pets." Fig. 4 is one of a pair of vases in sage green and white relief, the subjects being "Peace and War," modelled by C. Toft, who is now on the staff at Etruria.

The plaque shown in Fig. 5, represents the Apotheosis of Homer, which was modelled by Flaxman, between 1777 and 1779. The subject is adopted from the original bas-relief in the British Museum, which was afterwards bought by the British Museum from the Colonna Palace at Rome. The chimney-piece (fig. 6), shows the plaques fitted up at Haddo-house, for the Earl of Aberdeen, which are in sage green, and white bas-relief. These are copied from the originals belonging to Lord Tweedmouth, and fixed in his library and drawing-room at Brook-house, Park-lane. The centre plaque represents the Apotheosis of Homer, as in the round plaque (Fig. 5). A companion chimney-piece contains a plaque on which the Apotheosis of Virgil is shown. Several other plaques in sage green and white jasper, made for Lord Aberdeen, were shown.

In the decoration of Lord Dysart's mansion, at Buckminster-park, Grantham, which is now being reconstructed by Mr. H. R. Ricardo, plaques and medallions are being largely used Some of the solid jasper fronts for clocks, and the medallions and plaques were exhibited.

Of the black basalt there were several specimens, in busts of a Faun, of Venus, Washington, and Seneca. Specimens of the Queen's ware, in cream colour and white, were shown, also the Wedgwood Victoria bas-relief, a new form of manufacture, from the original models of Flaxman, but decorated in accordance with a more modern taste.

True porcelain was not made by Wedgwood himself, but after his death, his nephew, Thomas Byerley, produced some. The manufacture was, however, discontinued at the beginning of the present century. About

1879, new works were added to the original establishment, and porcelain is now one of the productions of Etruria. Several plates and portions of tea services, in various colours, one being richly decorated in blue and gold, were here exhibited. Two plaques, painted in colours by L. M. Lessore, were also exhibited.

The Worcester Royal Porcelain Company exhibited an important collection of vases and other decorative objects besides services, showing the various classes of decoration now in use in the works at Worcester.

Fig. 7.

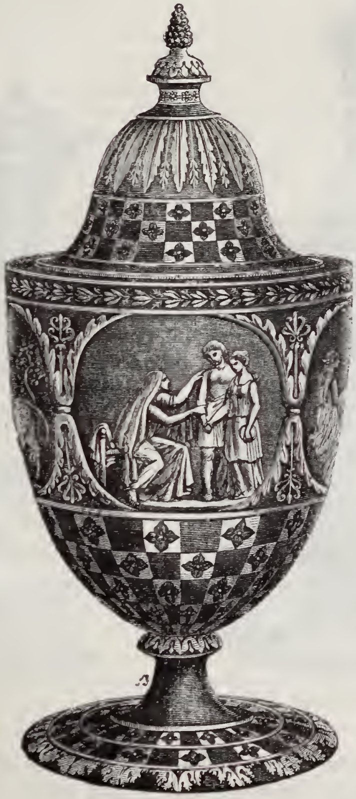
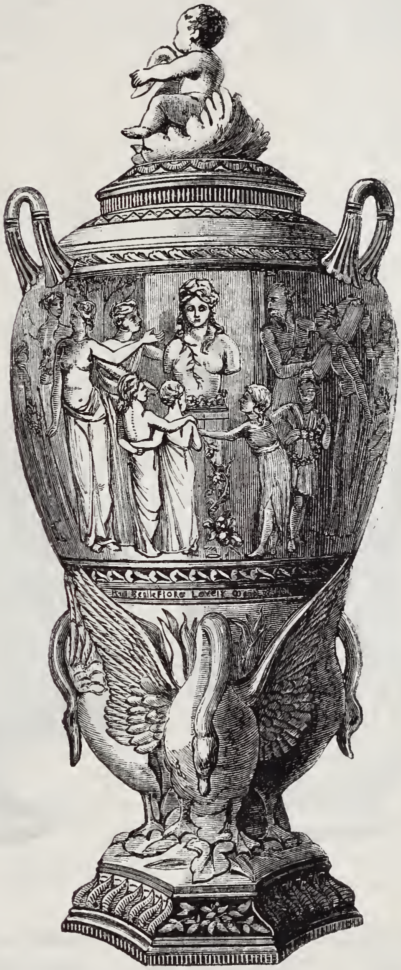


Fig. 8.



Wedgwood Vases.

On the site of these works the original establishment was founded in 1751, and some of the old buildings still remain. The first important alterations were carried out in 1840, and many additions have subsequently been made. The fame of the works is originally due to Doctor Wall, who produced a beautiful artificial porcelain as the result of his scientific researches. Dr. Wall died in 1776, and the remaining partners carried on the works until 1783, when the whole establishment was sold to Mr. Flight. Many changes have been made since then, and the present Joint Stock Company commenced in 1862, with Mr. R. W. Binns, a previous partner, as managing director. The earliest designs of the original Worcester Company were nearly all painted in blue, In 1756, transfer printing was introduced, both with finely engraved black prints on the glaze, and with blue prints under the glaze, which with difficulty could be distinguished from the painted subject.

At present the manufacture of the works embrace the following varieties:—Fine porcelain, ivory porcelain, vitreous stone-ware or semi-porcelain, crown-ware, parian majolica, terra-cotta, &c. The raw materials used consist of china clay and china stone from Cornwall, felspar from Sweden, fireclay from Stourbridge and Broseley, marl from Broseley, flint from Dieppe and Gravesend, calcined bones, both home and American. Among the special styles of ornamentation used at present are, perforated porcelain, jewelled porcelain, Raphaelesque decoration, bronze and metallic decoration, modelled and coloured golds, as exhibited at Paris in 1878 and enamels on Royal blue, painted *en grisaille*, or Worcester enamels. The objects in the Exhibition were entirely of porcelain, and did not include any of the other materials mentioned in the above description. The vases, jugs, &c., were mostly of ivory porcelain, a special body introduced by Mr. Binns twenty-six years ago, when he was in partnership with Mr. Kerr. This beautiful groundwork has been used for a variety of styles, as the pervading tone gives effect to the ornamentation placed upon it. Italian and Japanese designs have been followed, but most of those shown were in the Persian manner, and three of the chief of these are shown in the above illustrations.

Fig. 9.

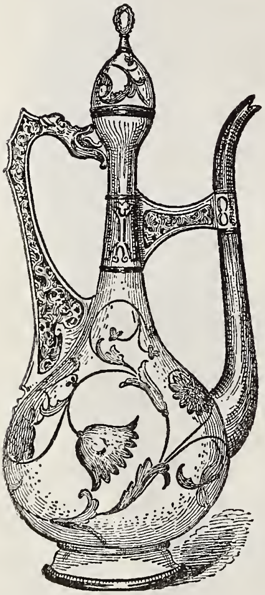


Fig. 10.

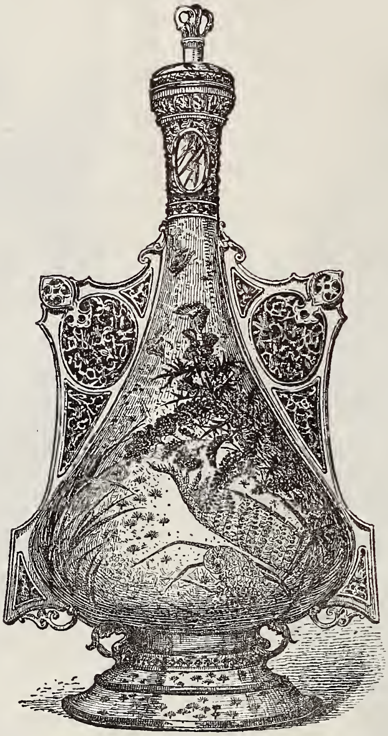
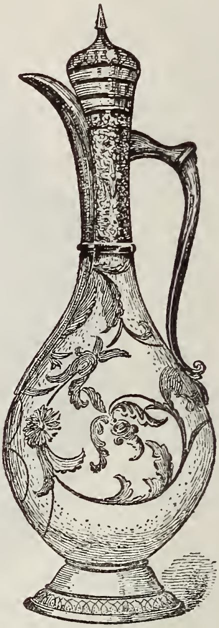


Fig. 11.



Vases and Jugs of Worcester Porcelain.

The ewers on either side of the central vase are of fine ivory groundwork with Persian designs, modelled in gold and bronzes of various colours, the handles being elaborate specimens of richly perforated work. The centre vase is one of the finest works at present produced by the Company. The ivory ground is covered with diaper work, and upon this the artist has made an arrangement of natural ferns, modelled and gilded with great delicacy.

There were many other jugs and vases which exhibited several varieties of decoration, and also cups and saucers, specimens of services in many different colours.

It will be seen, from the remarks on the objects shown by the seven firms already mentioned, that a very representative collection of the chief examples of the development, during the last few years, of modern English pottery was gathered together in this Exhibition.

EXHIBITION AND COMPETITIONS AT GHENT.

The Chambre Syndicale Provinciale des Arts Industriels was founded at Ghent, in 1866, with the object of "stimulating the genius of artistic creation in relation to industrial applications, contributing to popularise the study and sentiment of the beautiful in the production of industrial objects, which derive a portion of their value from their form, so facilitating and encouraging the efforts of industrial artists and artisans in the conception and execution of original works of good taste." Its first exhibition,* which opened on August 12th, 1877, at the Palais de l'Université, Ghent, exerted a distinct influence on the manufactures of the country; while the retrospective collection that accompanied it, stimulated the taste for objects of ancient art, and the reproduction of artistic models. At the same time it was noticed that the art of industrial drawing had not kept pace with the demands of manufacture. Accordingly, as it was impossible to organise an exhibition, every year, the Chambre Syndicale, with the special object of improving the art of industrial drawing, and of improving the position of the draughtsman, instituted an annual competition in designs, to which was added an exhibition of illustrated works bearing upon the subject. At the first of these competitions, which was held in 1879, there were ninety-nine entries for the nine competitions, seven first and seven second prizes being awarded. In the following year there were over a hundred competitors in the twelve competitions, the first prizes being withheld in only a few instances. Last year, the number of competitions was increased to twenty, and included designs for a ceiling, an entrance door, a cast-iron pump, a wrought-iron balcony, a staircase, &c., the first prizes being withheld in five cases, while the number of entries are gradually increased.

For the present year, the Chambre Syndicale announce an Exhibition of Industrial Art, to open in the halls of the Ghent Casino, on 28th August, and to continue until the 18th October, following. Like the former, it will comprise two sections:—1. Modern, including: (*a*) a general exhibition of objects of industrial art manufactured in the country; (*b*) competitions in designs for such objects; and (*c*) competitions in manufactured objects. 2. A section of objects anterior to the 19th century, relating to industrial art, Belgian or foreign. Besides the prizes in the competition, medals of silver-gilt, silver and gold, as well as honourable mentions, will be accorded to such exhibits as evince the greatest merit in design, taste, and execution, or which illustrate a new industry; while medals will also be granted to the designers of successful exhibits. It is expressly desired that the selling price be affixed to the exhibits. Works intended for competition, which must be strictly original, are to be deposited anonymously before 12th August, a clause which, it is announced, will be rigorously observed. The competitors are not restricted to Belgians, but are extended to those who have lived three years consecutively in that country. The committee reserve the right to purchase the works entered, at the prices stipulated in the programme.

The following is the classification decided upon for the modern section of the forthcoming exhibition:—

Division A.—*Building.*—(1) Ornament in stove, carton-pierre, plaster of Paris, artificial stone, &c.; (2) natural and artificial marbles, pavement, &c.; (3) joinery, including doors and floors.

Division B.—*Furniture and Decoration.*—(1) Decorative painting on stone, wood, cloth, graining and marbling; (2) cabinet making, including furniture in which wood predominates; furniture with the application of marquetry and inlaid metal work, including carriages and sledges, pianos, and articles of furniture connected with telegraphy and telephony; (3) wood frames, gilded or not, for mirrors, pictures, &c.; (4) earthenware and porcelain, moulded and cut glass; (5) stained and engraved glass, mirrors; (6) wall paper and imitation leather.

Division C.—*Metal Industry.*—(1) Goldsmith's work, jewellery, watchmaking, engraving on cameos, &c., enamelling, nickelising, chasing, &c.; (2) ecclesiastical art; (3) artistic bronzes, wrought and cast-iron, clocks, appliances for lighting and heating, stoves, fenders, &c., electro-metallurgy, arms and cutlery; (4) wrought and cast iron-work, including balconies, articles in brass and zinc, the panels of doors, gates and locks, door-handles, bells, knockers, &c.

Division D.—*Textile Industry.*—(1) Various wove fabrics, shawls, &c.; (2) bookbinding, tickets, &c.; (3) printing, engraving on stone, on wood, on zinc, and on copper, chromo-lithography; (4) photography in its application to industrial art, to the exclusion of portraits and landscapes (the proofs must be permanent, *i.e.*, obtained by the carbon process, heliography, photo-lithography, &c.); (5), models for the teaching of drawing, reproduction of objects of ancient art in plaster and wood, or by electro-metallurgy; materials for the arts of painting and drawing; designs and models of industrial art, &c.

The competitions of the first series include designs for a mantel-piece, a funeral monument, a candelabrum for gas, a book-case, a cabinet, a staircase window, a pulpit, an ecclesiastical gaselier, a carpet in seven colours, and an epergne; and of the second series (executed works), the furniture and decoration of an office, a staircase *jardinière*, a telescopic table, four chairs, a porcelain dinner service, a tablecloth and dozen napkins, an ecclesiastical lamp, artistic and economical bookbinding, and a *coureuse* carriage.

The Président d'Honneur is M. Léon Verhaeghe de Naeyer, Governor of East Flanders; the president M. Constant Verhaeghe de Naeyer; and the secretary, M. Emile Varenbergh, Ghent.

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* See the *Journal* of September 21st, 1877, No. 1296, Vol. xxv., p. 971. The Report of the Chambre Syndicale, published in 1881, is deposited in the Library.

PREVENTION OF SEA SCURVY.

A Report of the Board of Trade on Sea Scurvy, Food Scales, and Anti-Scorbutics in Merchant Ships, signed by Mr. Thomas Gray, and dated July 27th, 1882, has lately been printed. An abstract of the chief points dealt with in this report are here given.

"The Merchant Shipping Acts do not in any way prescribe the quantity or the sort of food to be supplied to seamen on board British merchant ships. The food scale is a matter of contract settled between the master and the seaman for each ship for each voyage, and the scale agreed upon is under section 149 of the Merchant Ship Act, 1854, to be set forth in the articles of agreement with the crew. The scale having been agreed upon, power is given by section 221 of the same Act, whereby a survey may be made of provisions which may have been complained of as of bad or insufficient quality, and under section 223, compensation is to be given at the rate there stated for bad or insufficient provisions. Surveys have occasionally been held under the Act, but very few cases have been reported to the Board of Trade in which the crew have been paid compensation. It is, however, possible, and even probable, that crews may have been compensated without the fact being reported to the Board of Trade.

"By Section 4 of the Merchant Shipping Act of 1867, a supply of lime juice and other anti-scorbutics to ships' crews were arranged for; but there is reason to believe that the monotony of the food scales inserted in articles of agreement is very injurious, and that if these food scales were more suitable to the requirements of the present day, that the statutory ration of lime juice might be reduced. There is a general agreement, although there may be many predisposing causes, that sea scurvy is essentially a dietetic disease, having for its immediate origin the starving of the blood of some essential ingredient, which vegetable food readily supplies and renews. But whatever may be the cause of it, two facts are continually proved and reproved, viz., that it mostly occurs when a monotonous salt diet is kept up, and that its ravages are most felt by debilitated seamen, notably those who have got into a bad state of health by debauchery and indulgence on shore after a previous long voyage."

In noticing the various items of provisions, Mr. Gray mentions "canned" or tinned provisions, and specially alludes to the "Barff" process, which he says, if commercially practical, will exert an important influence on the providing the crews of merchant ships with fresh meats. In January, 1868, it was suggested that a statutory scale of provisions might be framed with advantage, and Doctors Leach and Dickson prepared separate scales. These were afterwards combined into one, which is printed in the report. Respecting this it is said:—

"The noticeable points in the model scale are, that it gave prominence to preserved and fresh meat or soup and bouilli, as a substitute for salt meat, and especially required fresh potatoes to be served out daily when practicable, or substituted for them preserved potatoes, onions, carrots, turnips; and it proposed that currants, or other dried fruits, and other anti-scorbutics should be served out in all cases.

"A circular asking the local marine boards for their opinions on the scale itself, and upon the proposal that it should be universally adopted unless another scale be specially agreed upon between the seaman and the owners, was issued in March, 1868. The replies to the circular were generally unfavourable, and practically nothing was achieved."

The necessity, however, of new dietary scales was continually enforced in the reports of the sanitary officers appointed to inquire into cases of outbreak of scurvy.

As typical of these representations, the following may be quoted:—

"*Dr. Spooner.*—'If fresh or preserved meat were given out alternately with salt, and a mess of fresh or preserved vegetables given every other day for the first two or three months of a voyage, few cases of scurvy would be heard of.'

"*Dr. Charteris.*—'The men were becoming rapidly worse ('Cape Horn') when the pilot boat reached them off Cape Clear, and a fresh supply of provisions being obtained for them, improvement was quickly manifested.'

"*Dr. Humphreys.*—'Lime juice, though an excellent anti-scorbutic, and to my mind, indispensable at sea, will not supply the place of fresh meat and vegetables.'

"*Dr. Spooner.*—'I think it highly desirable that a radical change should take place in the present system of diet. Greater variety of food, fresh meat, at least twice a week, more preserved vegetables, pickles, &c., would be beneficial.'

"*Dr. Spooner* again, in reporting so recently as 2nd December, 1881, says:—

"'I consider scurvy to be a disease caused essentially by mal-nutrition of the body. There is no doubt that the immediate cause of the disease, without which it never occurs, is a deficiency of vegetable food, for which lime juice may be considered an imperfect substitute. There are, however, certain secondary or predisposing causes which favour its development, such as—

"'1st. Previous bad state of health, and residence in a malarious district.

"'2nd. Exposure to cold and wet, combined with imperfect clothing.

"'3rd. Bad quality of the provisions, and improper cooking.

"'4th. Deficiency of absolute nourishment, and too great monotony in the diet, and improper adjudication of the nutriment and respiratory principles of the food.

"'I consider scurvy an eminently preventable disease, but it can only be thoroughly eradicated by some such scale as I have drawn out being made compulsory, or by inflicting a severe fine, say £100, on any master or shipowner on whose ship scurvy occurs, unless it is clearly proved that it was not his fault.' "

The Legislature of the United States took the matter up a few years ago, and copied, to a certain extent, the statutory enactments in our Acts. They adopted lime juice as a statutory anti-scorbutic, but they arranged a scale of provisions of their own. Respecting this, the report has the following observations:—

" In the mercantile marine of the United States sea scurvy is rare (excepting, of course, in whalers' long voyages); and that scurvy is rare is to be accounted for by the fact that, although the daily scale inserted on the articles of agreement of the United States ships is much the same as the English, it is inserted as a matter of statutory requirement only, and is rarely adhered to. At breakfast the crews of the United States ships often have 'mash,' which is corn meal porridge mixed with molasses; preserved meat is generally given twice a week, fish twice a week, on pork days, and plum duff twice a week. But the most important fact is that a large quantity of fresh potatoes, four or five tons, is generally put on board, so that fresh potatoes are given every day during the voyage.

" The crews of American merchant ships also drink largely a concoction known as 'switchel,' which is composed of molasses, vinegar, and water.

" Dr. Spooner, the sanitary inspector of the ships at Liverpool, has been ordered again to prepare scale, and to report on the subject of food and sea scurvy generally. His report contains the following passages, viz.:—

" 'In considering the present scale of diet, it becomes apparent that it has been constructed with a total disregard to the physical wants of the system; that in addition to its monotonous character and lack of vegetables, the proportion of the nutrient and respiratory principles is altogether wrong. It has been proved by experiments that for healthy nutrition the nutrient nitrogenous or flesh-forming elements should bear to the respiratory or carbonaceous the proportion of about 1 to 5 or 1 to $4\frac{1}{2}$; and according to Dr. Lyon Playfair, a man doing active but not excessive hard work, requires daily about 5·5 oz. of flesh-forming food and 36·3 oz. of carbonaceous food. In the scale allowed in the Navy the flesh formers = 5 oz. and the heat givers 20·4 oz., the ratio being as 1 to 4; whilst in the Army the flesh formers 4·2 oz. and the heat givers 22·06 oz., the ratio being as 1 to 5·2.

" 'I have calculated the amounts of these constituent parts in the ordinary scale of the merchant sailor, according to the table of Dr. Lyon Playfair, the fat, sugar, and starch, the three heat-giving principles, being reduced to one equivalent, viz., that of starch, and I find that it consists of 6·912 oz. of flesh formers, and 22·416 oz. of heat givers, the former standing to the latter in the ratio of 1 to 3·3; thus it appears that the diet of merchant sailors contains a greater amount of nitrogenous food than is required for a man in active labour, greater even than a navvy employed in the very severe work of a railway cutting consumes, and this is owing to the excesssive quantity of animal food. In the scale I have drawn out, I have endeavoured to remedy this by reducing the amount of flesh-formers and imcreasing the heat-producers, and have thus brought the ratio to about the proper proportion, the quantity of each being very liberal. The diet, generally, according to this scale, is of a much more varied character, and contains a due proportion of vegetables, the want of which produces scurvy. There is no doubt fresh vegetables are more anti-scorbutic than preserved ones, and therefore it would be better that on all occasions there should be a good supply put on board enough to last for two months on leaving England, and these could be renewed at the different ports. I have also calculated the price per man of the scale I have drawn out, and compared it with the present scale, and have thus proved that the extra cost need be very slight; in fact, the cost is less than in some good firms, such as the British Shipowners and Brasseys. I annex some provision scales which I procured from some of the best provision merchants in Liverpool, from which it will be evident that the stores they are in the habit of supplying to sailing ships correspond very closely with the scale I obtained from the shipping office, and which is the ordinary one signed for by the crew. I may observe that, although the scale mentioned is all the sailor can legally claim, yet many shipowners are in the habit of giving in addition a mess of soup-bouilli on Sundays, aud some also give oatmeal and molasses occasionally. It is also becoming an increasing custom to give 1 lb. of butter per week in lieu of some of the salt meat, and sometimes, as in the British Shipowners' Company, Messrs. Bates, Brasseys, and others, marmalade and pickles are also supplied; but still these liberal-minded shipowners are in the minority. The majority still cling too closely to the old dieting scale, which has received the sanction of long custom.

" 'I have given preserved meats three days a-week instead of two days salt beef, and one day salt pork, as I think preserved meat more digestible, and contains more nourishment for the money, being cooked and having no bone. The total quantity of meat is as much as is allowed to soldiers on transport ships. I have included preserved carrots, as they are very much nicer than the compressed vegetables, although somewhat more expensive. The latter, as supplied to ships, are not palatable, or appreciated by the crew. Preserved potatoes, however, are very good, as I have myself tried them, and found them excellent.

" 'I have given more flour, and added raisins and suets, in order that plenty of plum-duff may be issued; this is always liked.

"PROPOSED VICTUALLING SCALE TO BE SERVED OUT TO THE CREW PER DAY, IN ADDITION TO THE ISSUE OF LIME JUICE AND SUGAR REQUIRED BY LAW. (BY DR. SPOONER.)

	Biscuit.	Flour.	Beef.	Pork.	Preserved Meat.	Peas.	Preserved Potatoes.	Preserved Carrots.	Butter.	Oatmeal.	Rice.	Marmalade.	Sugar.	Raisins.	Molasses.	Suet.	Pickles.	Tea.	Coffee.
	oz.	oz.	lb.	oz.	oz.	pt.	oz.	oz.	oz.	oz.	oz.		oz.					oz.	oz
Sunday	12	8	—	—	12	$\frac{1}{3}$	—	8	2	—	—	1 lb. per week.	2	$\frac{1}{2}$ lb. per week.	$\frac{1}{2}$ pint per week.	4 oz. per week.	4 oz. per week.	$\frac{1}{8}$	1
Monday	12	—	1	—	—	—	2	—	—	4	—		2					$\frac{1}{8}$	1
Tuesday	12	8	—	—	12	—	—	8	—	—	—		2					$\frac{1}{8}$	1
Wednesday..	12	8	—	12	—	$\frac{1}{3}$	2	—	2	—	4		2					$\frac{1}{8}$	1
Thursday....	12	—	—	—	12	—	—	8	—	4	—		2					$\frac{1}{8}$	1
Friday......	12	8	1	—	—	—	2	—	2	—	—		2					$\frac{1}{8}$	1
Saturday....	12	8	—	12	—	$\frac{1}{3}$	2	—	—	—	4		2					$\frac{1}{8}$	1
One man per week	5·4	2.8	2·0	1·8	2·4	1 pt.	8 oz.	1·8	6 oz.	8 oz.	8 oz.	1 lb.	14oz	8 oz.	$\frac{1}{2}$ pt.	4 oz.	4 oz.	1 oz.	7 oz.

"SUBSTITUTES.

"Fresh meat to be given instead of salt, and preserved as long as possible after leaving port.

"Fresh potatoes, carrots, &c., $3\frac{1}{2}$ lbs. per week, instead of preserved vegetables, as long as they last.

"Oatmeal may be substituted for rice in cold weather, and *vice versâ*, in hot weather.

"Preserved onions may be substituted for preserved carrots."

"'Marmalade has lately been issued in some ships, and has been found to answer well.

"'Oatmeal and molasses will do well for breakfast, and I have endeavoured to keep the cost as far as possible within due limits.'

The practical conclusions are tabulated as follows:—

"1. That scurvy has been on the increase in British ships since 1873.

"2. That lime juice, of itself, will not prevent scurvy, and that too much reliance is placed on it, to the neglect of varied food scales.

"3. That lime juice, in connection with fresh or preserved meat and vegetables, may prevent scurvy.

"4. That the dietary scale of ships should therefore include a fair proportion of fresh and 'preserved' meats as distinguished from 'salted' meats.

"5. That more fresh vegetables should be carried, notably raw potatoes. No satisfactory reason is given why fresh potatoes cannot be carried on board British ships. The allegation that they will not keep good on board is clearly disproved by the fact that they do keep on board United States' ships: and will keep for a fair time anywhere else.

"6. That it is not at present desirable to insert a statutory scale of diet in the articles of agreements with crews serving on long voyages, though it may possibly be necessary hereafter, unless the shipowners themselves move in the matter."

The report contains the following table as an Appendix:—

STATEMENT OF NUMBER OF SCURVY OUTBREAKS REPORTED TO THE BOARD OF TRADE, FROM 1866-1881, INCLUSIVE.

Year.	No. of Outbreaks.	Year.	No. of Outbreaks.	Year.	No. of Outbreaks.
1866......	33	1872......	40	1878......	84
1867......	88	1873......	19	1879......	93
1868......	90	1874......	30	1880......	92
1869......	22	1875......	58	1881......	99
1870......	22	1876......	69		
1871......	34	1877......	80		

LOCOMOTIVE GAS-ENGINE.—It is reported in *Herapath's Railway Journal*, from the United States, that an Erie Road locomotive, fired entirely by hydrogen gas, produced by the chemical decomposition of water under the action of ignited naphtha, was successfully run from Paterson to the station in Jersey City, making the trip one minute and ten seconds ahead of time, and coming into the depôt with a pressure of 140 lb. of steam, being nearly three times as much as the ordinary locomotives carry at the end of such a trip. The engine had been constructed under the supervision of the inventor. During the above trip so much steam was generated, that the safety valve had to be opened nearly all the way. The amount of naphtha used for $19\frac{3}{4}$ miles was 84 gallons, costing $2·08, or about one-third of the cost of coal usually consumed for the distance. No smoke, sparks, or cinders are produced.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

SOCIETY OF ARTS EXAMINATIONS.

Programme for 1883.

The attention of Secretaries of Institutions and others interested in the Society of Arts Examinations is especially drawn to the fact that important alterations have been made in the examination system. The following are the principal points in which changes have been made since the publication of last year's Programme:—

1. The Examinations in subjects of "Commercial Knowledge" have been renewed.
2. The three subjects, "Clothing," "Cookery," "Housekeeping," &c., will be comprised in a single paper, under the head of "Domestic Economy." The examination in "Health," will be continued under the title of "Sanitary Knowledge."
3. A fee of 2s. 6d. will be required from each candidate in each subject, except "Practical Music," for which special fees are required.
4. No prizes will be given in any subject.
5. Certificates in *three* classes will be given.
6. The restriction as to the age of the candidates has been removed.
7. An examination will be held in any subject of "Commercial Knowledge," in addition to those already in the Programme, for which 25 candidates offer themselves, provided the Council approve of the subject.

The Council wish it to be understood that the continuance of the Examinations must depend on their practical success, as evidenced by the number of candidates offering themselves for examination; the scheme having been revised in consequence of applications received from certain of the Institutions in Union, it rests with the Institutions to make the Examinations as successful in the future as they have been in the past. It may also be mentioned that the fee charged has been calculated on such a scale as to make the Examinations, as nearly as possible, self-supporting.

Subjects.

The subjects of Examination for 1883 will be—

1. Arithmetic.
2. English (including composition and correspondence, and précis writing).
3. Book-keeping.
4. Commercial Geography and History.
5. Shorthand.
6. French.
7. German.
8. Italian.
9. Spanish.
10. Political Economy.
11. Domestic Economy.
12. Sanitary Knowledge.
13. Theory of Music.
14. Practical Music.

In addition to the above subjects, the Society will provide for an Examination in any other subject which may fairly be comprised in "Commercial Knowledge," and of which the Council approve, provided not less than 25 candidates are guaranteed for such subject.

The Examinations, in all the subjects, except Practical Music, will be held on the evenings of Monday, the 9th, Tuesday, the 10th, and Wednesday, the 11th of April.

Elementary Examinations.

The Society will also supply papers and forms for such Institutions in Union as may desire to conduct an Elementary Examination in Arithmetic, English History, English Geography, English Grammar, and Rudiments of Theory of Music.

The complete Programme will shortly be ready, and can be had upon application to the Secretary.

LONDON WATER SUPPLY.

The Annual Report of the Thames Conservancy Board,* issued on August 8th, contains this intelligence:—"The river above the intakes of the water companies is now practically free from sewage contamination." The report, though dated July 17th, 1882, refers to the year ending the 31st December, 1881, the delay of printing being due, as it is each year, to the preparation of the accounts. The Act of Parliament, which gave the Conservators power to prevent the pollution of the river, was passed in August, 1866, so that, from the time when this authority was conferred on them to issue injunctions against those who caused sewage to pass into the Thames, to the time of the completion of the works which these injunctions involved, a period of fourteen years elapsed.

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* Ordered by the House of Commons to be printed, July 26, 1882. No. 315.

The effluent water from sewage farms still passes into the river, but many eminent authorities have given their individual opinion that, except with careless management, this is harmless, and the whole question of sewage farming has been discussed by the British Association, the Royal Agricultural Society, the Society of Arts, and other public bodies. It is a distinct gain that no sewage passes directly into the Thames above the intakes of the companies which supply London, and the announcement of the Board is a distinct epoch mark in the history of the London water supply. The work achieved has been slow in its progress, for such constructions as have been required have not only needed time but deliberation and forethought, but it has been done.

The London companies which supply Thames water are the Chelsea, the Lambeth, the Grand Junction, the West Middlesex, and the Southwark and Vauxhall. The East London also takes a part of its supply from the Thames at Sunbury. The intakes of the Grand Junction, the West Middlesex, and the Southwark and Vauxhall are at Hampton, the intakes of the Lambeth at Molesey, and of the Chelsea at Molesey and Ditton. Practically, they are all close together. "In the district between the intakes of the water companies and the western boundary of the metropolis, near Chiswick, sewage," the report states, "still passes into the river, the penalties against this pollution of the river being suspended for the present by an Act of Parliament. The Conservators hope that before September, 1883, the date when this Act expires, some scheme may be devised for diverting from the river the sewage of Kingston, Richmond, and other places in the Lower Thames Valley drainage district." This does not, however, in any way affect the water supplies which furnish the water for drinking and cooking, the intake of which is above this district.

Even without any of the filtering which is now affected by the larger filter beds of the companies, the Thames is incomparably superior as a drinking supply to what it was when the companies, in their early days, began to draw from the river at Charing-cross, at Chelsea, and at Vauxhall. The Royal Commission of 1828 has recorded, in a wood-cut, the "Dolphin," by which the Chelsea company drew its supply close to the mouth of the great Ranelagh-common sewer. Now, no sewage is allowed to run into even the tributaries of the Thames for ten miles each side of it. The improvement in the health of London is roughly shown by the Registrar-General's mortality returns, though the number of fatal cases is no exact index to the cases of illness; and these returns show a very decided reduction in those diseases whose spread is attributed to the use of water polluted with sewage, even if the years of epidemics are not used for comparison.

The way in which the Conservancy Board has been able to effect the great changes it has, is by firmly carrying out the duties assigned to it by successive Acts of Parliament.

When first constituted, in 1857, its duties were much the same as those of the old "Conservators," whose place it took. From "time immemorial," the Mayor and Corporation of London were "Conservators," down to 1857, but their authority was over landing-stages, fisheries, navigation, &c., and the prevention of throwing rubbish into the river, and these became the care of the newly constituted Board. It was not until the third Act of Parliament, which was passed in 1866, that any control over the pollution of the river was given. There had been, by this date, many Commissions and Select Committees,* which had directed attention to the condition of water supplies throughout the country, and the duty of preventing the pollution of the Thames was then assigned to the Board. It was not until ten years after, in August, 1876, that the Rivers Pollution Prevention Act was passed, applying to the whole country, an Act which in no way affected the Thames Conservancy Board. When the control was first vested in the hands of the new Board—the kind of control such as the old Conservators had—the extent of its jurisdiction was the same as that of the old Conservators, viz., from an imaginary line drawn from Yantlet Creek (Kent), to the north shore, opposite Cauvey Island (Essex), up to Staines, and it did not extend in width beyond the banks of the river itself. When, however, the powers for the prevention of pollution were added by the Act of 1866, the extent of the control was considerably increased, the whole of the river above Staines, up to Cricklade, being added. Still, the width was in no way increased; it was still confined to the river itself. By the Act of 1867 (the 4th Act) the width of jurisdiction was extended over the tributaries for three miles each side of the main river, so far only, however, as the power of prevention of pollution was concerned, and not as regards navigation and fisheries, &c., as in the main river. This power over the prevention of pollution was still further increased from three to four miles by the Act of 1870 (the 5th Act), and in the preamble the prevention of the inflow of sewage is alluded to as "for the purpose of preventing obstructions of navigation from the inflow of the sewage." The power over the prevention of pollution was again extended by the Act of 1878 (the 6th Act) from five miles to ten miles. Beyond this distance the tributaries are mostly small, and there are no towns or even large villages which send their sewage into them. Other powers and modifications, were provided for in the different Acts, but they have no reference to the power of prevention of pollution.

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* See "Notes on Previous Enquiries." National Water Supply. Published for the Society of Arts by Bell and Son, York-street, Covent-garden. 1878.

The provision made in the 63rd clause of the Act of 1866 has not been altered, and it is from this that the Board derives its executive power, so far as prevention of pollution is concerned. This clause declares it shall not be lawful for any person to do any of the following things:—(1.) To open into the Thames any sewer, drain, pipe, or channel, with intent or in order thereby to provide for the flow or passage of sewage or any offensive or injurious matter. (2.) To cause or suffer any sewage or any matter aforesaid to flow or pass into the Thames. If any person does any thing or act in contravention of this enactment, he shall for every such offence be liable, on summary conviction, to a penalty not exceeding £100, and to a further penalty not exceeding £50 for every day during which the offence is continued after the day on which the first penalty is incurred.

Clause 64 directs the way in which the Conservators are to proceed. Wherever any sewage, &c., is allowed to flow into the Thames or the tributaries for three miles on each side of it, or is conveyed in such a manner it is likely to flow into it, the Conservators are to give notice in writing under their common seal, requiring the person or persons causing or suffering the same to flow to discontinue the flow or passage within a time to be specified in the notice, not being in any case less than twelve months or more than three years. The subsequent Acts in no way changed the principle on which the Conservators were to act, but only extended the width of their control.

It will be noticed that while the Conservators have their own officers for carrying out part of the work entrusted to them, their power, so far as prevention of pollution is concerned, is to compel others not to cause pollution. That compulsion is requisite is seen from a passage in the last report quoted above which mentions that pollution still takes place in the metropolitan area over which the Board's control is suspended.

The success attending the serving of notices is shown in a return made to the House of Commons, July 12th, 1876. It gives a list of notices served in over thirty places. At Abingdon fifteen notices are mentioned, at Wallingford twelve, and so on. The principal places are Oxford, Abingdon, Wallingford, Goring, Pangbourne, Reading, Wargrave, Henley, Remennam, Great Marlow, Cookham, Maidenhead, Windsor, Windsor Castle, Old Windsor, Eton Union, Eton College, Slough, Datchet, Clewer, Egham, Staines, Chertsey, Shepperton, Weybridge, Walton, Sunbury. The dates of completion of such works as were completed are given, and they range from Oct., 1870, to June, 1876. Since the issue of the return, the works at Windsor were completed by October, 1877, and those at Abingdon and Reading by the end of December, 1877. During the year ending December, 1881, some hitherto overlooked cases of pollution on the tributaries have been reported by the inspectors, and in five cases convictions were obtained. Some few cases may still have escaped detection, but now "the river above the intakes of the water companies is practically free from sewage contamination."

This report of the Conservators gives the state of the Thames as it is used as a source of supply by the companies. The inspection of their settling beds, impounding reservoirs, and filter beds, is entrusted to the water examiner, under the Metropolis Water Act. The chemical examination of the water, as delivered by the companies, is made officially by Professor Frankland, whose reports are given in the monthly reports of the Water Examiner (Colonel Bolton). Examinations, made by other chemists, are also issued unofficially, These reports refer to "organic matter" generally present in the Thames water. As this last report of the Conservancy Board gives the official statement that practically no sewage matter is present, whatever other organic matter chemists may find, must come from other sources. The public mind, so often frightened by announcements of "previous sewage contamination," need no longer rest its faith in periodical immunity from this upon the varying skill of the chemist.

LILLE EXHIBITION.

An International Exhibition of Industrial Art was opened at Lille on 8th April, in the Palais Rameau, built by the Municipality in honour of M. Charles Rameau, horticulturist, who left the whole of his fortune for the erection of a building in which to hold annual horticultural exhibitions. The catalogue has been prepared with more than usual care; and as it is always found impossible, in Exhibitions, to arrange the objects exactly in any predetermined order, reference is made, by letters, to the portion of the building where each exhibit is placed. The lithographed plan, showing the various portions of the building, lettered to correspond, is printed so as to project entirely beyond the text, and thus save a great deal of trouble. A large paper edition of the catalogue,* with photographs of the principal exhibits, is published at a very moderate price.

The principal objects exhibited are decorative carving and sculpture, art metal work, textile fabrics, chiefly applied to furnishing, painted windows and pottery, of which latter, the shows of Doulton and of Minton are among the best.

In Section I., "Building," there is a portion of staircase in artificial stone, part of it resembling marble, by M. D. Delgutte, of Lille, who undertakes to execute a staircase one-flight high, in a single "coulée," that is, without joint, and to warrant it for ten years. An improved and patented casement sash, arranged so as to exclude draught and rain, is sent by M. Fougnies-Barigand, of Peruwelz; and a hollow cast-iron cill for casement window, forming a gutter to carry off any rain which may beat in from outside, and the condensed breath inside, by M. A. Seidel, of Lille. A protection from the sun or cold, for frames and greenhouses is shown by M. Richez-Bourdon, of Lille, in his "claies roulantes," which consists of laths loosely jointed together with wire, and rolled up from the bottom by pulling a cord passing underneath. An improvement in venetian blinds is made by M. Georges Garette, Lille, by hanging them with a light brass chain instead of cord, so that there is none of that hanging and sticking so frequently noticed. A new substance for roofing buildings, and also for laying down on damp floors, and for lining damp walls, is shown by M. J. Hautrive, of Lille, applied to a small erection in the garden, enclosing the raw materials from which it is manufactured. It is woven of hemp, or other similar material, and coated with a bituminous substance, rendered unattackable by the atmosphere by a deposit of metallic lead. The Paris official tariff of prices for various classes of roofing is quoted, to show that roofs formed with this "metallised cloth" compares very favourably in price with all others: it is also claimed to be impervious to water, a non-conductor of heat, and non-inflammable.

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* A copy of this edition, showing some highly artistic industrial designs, will be found in the Library.

Besides "Furniture," Section II. includes all that relates to furnishing a house. Among the heating appliances, the "Calorifère Universel" of De Surmont Frères, appears to have a wide application in French educational establishments, testimonials from the Mayor of Lille, and the principal of the Douai Academy, testifying to its efficiency. The fire-grate is surmounted by a kind of annular drum mounted on its periphery, and pierced with a dozen cylindrical holes, through which the air passes, while the flames and hot gases circulate round them. In one form, surrounded by a casing, the air-supply, derived from the exterior, passes out into the room after being heated. Among a large variety of door fastenings, shown by M. J. B. Fondu, of Brussels, there is a safety catch used in the carriages of the State railways of France, which shows, on the inside, whether it is open or shut. Some jointed iron trestles, that fold up into a small space, are shown by M. A. Acolet, of Compiègne, who performs a parallel to turning swords into ploughshares by making handsome candelabra from bayonets. Picture-frames having the appearance of polished bronze and other metals, are contributed by M. A. Chevalier, of Lille. M. Deckers, of Lille, sends a "levigrave" piano, by Dumas, in which any amount of resistance desired may be given to the key-board; it is fitted with a *pianissimo* pedal, which is capable of reducing the sound even to the extent of rendering the instrument mute.

In Section III., "Tissues and Hangings," the most interesting exhibit is a collection of textile fabrics, showing the application of flax and jute to the decorative industries by the processes of Jules Imbs. They consist of flax-silk and jute-silk, each containing only 15 per cent. of silk, but yet forming velvet, lace, and other fabrics that have all the appearance of being made entirely from the more expensive substance. In a dining and drawing-room fitted up by M. L. Demeuter, of Brussels, the panels are of imitation tapestry, one woven and the other painted cloth.

Section IV., "Jewellery," embraces work in gold, silver, aluminum, nickel, enamel, &c.; and a model, 1-10th the real size, of a workshop for making articles in nickel, with all the machines and appliances, is shown by M. Herber-Bary, of Brussels. Shirt-studs are sold by M. G. Antony, of Paris, in which the shank is in two parts, a kind of pin with spring end fitting into a socket.

Section V. includes all the exhibits that could not be classed with the other sections, and also publications and scholastic appliances. The galleries are hung with highly creditable performances, including paintings of real value, executed by pupils of the various Government schools of Lille. These are the Ecole Supérieure et Professionelle (director, M. V. Loridan), the Ecole Supérieure de Jeunes Filles (directress, Mdlle. Deghilage), the Ecole Primaire Supérieure de Garçons (director, M. Tilmant), the Ecole Municipale (director, M. A. Jennepin), and the Ecoles Académiques; and the most distinguished pupil appears to be Mdlle. Angèle Fauché, whose paintings and crayon drawings on silk attract a great deal of attention.

Some innovations in mechanical drawing are introduced by M. Ed. Jardez, of Lille, who shows a cheap drawing-board of prepared poplar wood, framed to receive a panel on which the paper is stretched, and secured by iron bars with bevelled edges. The board need not be square, nor have true edges, because the T-square, with grooved stock, is worked along a straight-edge, clamped down on the left-hand side. This straight-edge is divided from zero in the middle, according to a metrical or other scale; and an aperture, serving as sight, is made in the stock, its edge corresponding with that of the blade. The blade is also graduated; and a kind of half T-square, like that used by joiners, is worked along it, instead of a set-square. For parallel oblique lines, all that is necessary is to shift one of the pins, clamping down the straight-edge; and perspective diagonals, with any vanishing point, are executed with a special straight edge. M. Jardez also makes a simplified form of pentagraph, which he supplies to schools for a franc. The outline maps of M. A. Bouvey, and the outline globes of M. M. Lebêgue et Cie, Brussels, both having an artificial slate surface for drawing upon, are cheap and useful adjuncts to the school-room.

The Exhibition, though not large, is well arranged, and has been visited by a large number of persons; the awards of the international jury will shortly be published.

THE COAL FIELDS OF NAGASAKI.

The field from which the main supply of coal for the Nagasaki market is obtained, is situated under the sea and islands, and along all the coast line, extending northward from Cape Nomo, in the south, up to the entrance of Nagasaki Harbour, and from thence in a westerly direction, almost to Hirado-shima, the most northerly of the Goto Islands. This field has an area of 900 square miles, but it is impossible accurately to define the limits either on the west or southern sides, owing to the fact that the strata here are totally submerged by the sea. Consul Jones states that the coal-bearing stratum of the Nagasaki district seems to be referred to the Tertiary period, though it is the opinion of Professor Nordenskiold, who devoted some time to the study of the rocks, that they might more justly be classed as Permian. The coal is described as being highly bituminous, of irregular appearance, inclining towards cubical, having, when freshly broken, a lustrous black appearance, which changes by protracted exposure to atmospheric influence, to a dull rusty black. The known seams of workable coal vary considerably in thickness, the thinnest seam wrought being one barely three feet in thickness, which is worked at Hira-shima; and the thickest being an 18 feet seam, worked at Taka-shima. Consul Jones states that is almost impossible, with any degree of accuracy, to state what the total thickness of workable coal may be, but the "Goto Tankosha," a mining company in whose hands the greater portion of the coal-field is placed, have already proved and worked at their Taka-shima mines, coal-seams of an aggregate thickness of fifty feet. The existence has also been proved, near Matsu-shima of two seams of coal, each measuring seven feet in thickness, and there are several seams of from four to six feet at present being worked on other islands, notably Koyaki, Iwo-shima, and Okishima, but in a primitive manner, by native miners. At present the supply of coal is almost entirely derived from the workings of the "Goto Tankosha" at their mines, which are situated on Taka-shima, a small island of from 300 to 400 acres in extent, lying about eight miles south-west from Nagasaki. As far back as history can be traced, a few fishermen were the only inhabitants of this island, and in making fires to light their fishing operations, and in certain seasons to attract the fish by lights suspended from their boats, they found and used for this purpose the first out-croppings of the coal, which circumstance originally attracted attention to, and was the cause subsequently of discovering the existence of, the coalfields. Coal was known to exist in, and has been obtained from, the island by the Japanese for the last two centuries, but the quantity extracted has been small, and the mining operations as carried on by them simple and rude, consisting principally in following down the coal seams from their outcrop at the surface, until the quantity of water draining in from above became too great for their rude pumping appliances to deal with. This latter event generally occurred at a point varying from 100 to 150 yards from daylight, and when it took place the working was abandoned, and fresh outcrops prospected for. The system of working which was in use in these old native operations was of a very rude description, bearing a strong resemblance to the old method for extracting the vein in metalliferous mining. Most of the mining operations which are carried on by native miners without the assistance of foreigners, still partake very much of this character, though they have been greatly modified by the example offered by the works which are being prosecuted under foreign supervision. At the present time the works are in the hands of a Japanese company, called the "Goto Tankosha," the miners being chiefly Japanese acting under the authority of a foreign manager and engineer. The average daily output of coal from this company's mines is at present about 1,000 tons, with the capacity for supply double that quantity when required. The coal is obtained from three separate seams, measuring respectively eight, ten, and eighteen feet. As most of the workings extend from the island out beneath the sea, considerable difficulties have to be encountered in contending with water, engines with a total of 200-horse power being used in pumping. The dip and rise of the stratum at Taka-shima being very steep, the haulage is carried on by engine power—the power being transmitted through steel-wire ropes of two and a half inches in circumference. The aggregate length of engine roads below ground is over three miles. As the workings have extended, large quantities of fire-damp have been encountered, and this has necessitated a very elaborate system of ventilation. Fans are in use for this purpose, which pass a quarter of a million cubic feet of air through the mine per minute. All the mines are illuminated by means of locked safety lamps, the "Clanny" being the form more generally in use. Several severe explosions have occurred in the mines, the last taking place in April, 1880, when several miners were killed. There are about 4,000 workmen in and about the Taka-shima mines; these include a very competent staff of mechanics. The coal is conveyed in native junks from Taka-shima to Nagasaki, about 100 of these being kept in constant employment. The labourers and miners of the Taka-shima Coal Company live on the island, in houses built by the company in Japanese style, and these form a considerable village. They are supplied with provisions by the company at cost price. The wages for ordinary labour are from fourteen to forty-five sens per day; skilled labour and the foremen of gangs receive higher wages, about seventy-five sens per day. The miners are divided into parties or squads of five persons, two to dig or cut the coal, and three to carry it to the tramways. These are paid in proportion to the quantity of coal they handle—that is to say, by the cattie. Women and children are employed in the mines, and receive the lowest wages, viz., fourteen sens per day. A day's labour consists of eight hours, either by day or night. A miner is at no expense for clothing, a straw sandal being usually his only garment. Consul Jones mentions a curious circumstance in connection with the subject of coal-mining, which is, that notwithstanding the abundant supply of coal, its proximity, convenience, &c., it is not used by the Japanese for heating or cooking purposes in the city of Nagasaki. The houses are constructed for a summer climate, without fire-places or chimneys, and are heated, when the weather is cold, by charcoal burned in small portable vessels, made either of metal, porcelain, or wood called "hi-bachies." The cooking also is done over the "hibachi." The Japanese Government have also lately opened out a new field of coal in the Higo district of the province of Nagasaki, at Müke. This new colliery is supplied with all the latest foreign mining machinery, and is carried out under the superintendence of a foreign mining engineer. It has an output capacity of from 300 to 400 tons per day, and the coal is shipped from the port of Kuchinotsu, which has been opened to foreign ships for that purpose. The yield of coal from the Müke mine, for the year 1880, amounted to 142,235 tons, of which 17,904 were sold in Japan, and 124,331 destined for consumption in China.

THE FIRST PHOTOGRAPHIC PORTRAIT.

The Field Naturalist contains an article, by Mr. Dudley Armytage, in which the question who took the first photographic portrait is answered in the following way:—

The discovery of Daguerre was made known in France in 1839, but the first sun pictures were of inanimate objects only, and its application to portraiture was regarded as somewhat chimerical. When the news of the new discovery reached America, Dr. John William Draper, putting an ordinary spectacle lens in a cigar box, began to experiment, and succeeded easily in obtaining views from the east windows of the New York University Chapel. One day he determined to try the experiment of taking the human face, which it was said Daguerre had not yet succeeded in doing, although M. Arago had stated that he was hoping soon to overcome the difficulties.

In October or November, 1839, having covered his assistant's face with white powder, and taught him to sit still for a long while, Dr. Draper managed to get a likeness. That was the first ever obtained by the Daguerre process. In April, 1839, Professor Morse and Dr. Draper opened a primitive gallery on the top of the University Buildings. Professor Morse was at that time teacher of painting and the fine arts, and Dr. Draper was professor of chemistry in the University of New York. Thus Morse supplied the artistic element, whilst Draper attended to the scientific manipulation. The gallery was not a very elegant one—an old room was used for a workshop, and a hastily constructed shed, with a glass roof, served for an operating room—but nevertheless it was a grand success.

During the summer vacation the firm had all the business they could possibly attend to at £1 a picture. All the best known people of the city sat for their portraits. Among others, a very good picture was taken of Mr. Frelinghuysen, then candidate for vice-president. The main drawback to the business was in the fact that it was only on very bright sunshiny days that they could succeed in getting anything like a satisfactory daguerrotype. On dark days they used to teach the art to would-be photographers, who came from all parts of the country to learn it.

Dr. Draper recorded his success in the *Philosophical Magazine* for September, 1840. This account is reprinted, with an historical note, in his "Scientific Memoirs." (London, 1878, p. 215.) From these sources, and from the *New York Herald* of January 5th, 1881, we have derived the above statements.

Dr. Draper soon found that it was a mistake to suppose that no impression could result unless the face of the sitter was dusted with a white powder. Duguerre required from twenty to twenty-five minutes to take a landscape, but under the brilliant sky of New York, on a bright day, and with a sensitive plate, Dr. Draper was able to take a portrait in the course of five or seven minutes. "The chair," he says, "in which the sitter is placed has a staff at its back, terminating in an iron ring, which supports the head, so arranged as to have motion in directions to suit any stature and any attitude. By simply resting the back or side of the head against this ring, it may be kept sufficiently still to allow the minutest marks on the face to be copied."

CULTIVATION OF FLAX IN NEW ZEALAND.

Consul Griffin states that *Phormium tenax* is by far the most valuable fibrous plant indigenous to New Zealand, and since 1809, it has been an article of export. The attention of Europeans was first directed to it by Captain Cook, who described it as something superior to either flax or hemp. The Maories have for many years used it for binding together the frame-work of their houses, and for making clothing, baskets, fine mats, fishing nets and lines, and sails for their boats and canoes. *Phormium tenax* is sometimes called the flax lily. The leaf varies in size from three to fourteen feet in length, and from half-an-inch to five inches in breadth at the widest part. It grows in bunches or groups of plants, each shoot has five leaves, and, on an average, about ten of these shoots form a bunch. The leaves are perennial, hard and sword-shaped, with a stalk rising five or six feet above them, bearing a profusion of yellow, and sometimes red flowers, followed by triangular pods filled with flat and thin black shining seed. The plant attains its full growth in three years' when the leaves generally split at the end, and it first comes into flower. It is said that in rich soil the flower rises to a height of twenty feet. The leaves are smaller than those of European flax and hemp plants, being composed of cellular trusses running the whole length of the leaf incased in a green substance. The trusses consist of two parts wood and bast, the latter forming the fibre so highly prized. The vascular bundles compose the inner bark of the plant, and serve to circulate the juices which are taken from the soil by the roots; these consist of exceedingly fine threads, one overlapping the other in such a manner as to give a free circulation throughout the leaf. The plant is indigenous to New Zealand and Norfolk Island, although it has been transplanted in India and other countries. It grows best in rich, moist, and well-drained grounds, and attains its maximum growth on the banks of running streams. When the leaves are full grown the natives gather them when green, and separate the fibres; they scrape the leaves with a shell, and then divide them with a comb. They are then put in the sun to dry, and when dry are perfectly white, soft and silky to the touch. It takes only a very short time to prepare the fibre, and about one ton of fibre is produced by the natives out of four and a half tons of green leaves. A full-grown plant will produce on an average about thirty-six leaves, besides shoots from the roots, and it takes about six leaves to yield one ounce of fibre. At this estimate an acre of ground planted three feet apart would yield about sixteen hundred weight of fibre. There are very many varieties of the *Phormium tenax*, among them being the *aonga*, a variegated flax; *atewhiki*, a very white fibre, used for making fine mats and garments, the leaf is narrow with a reddish tinge and bright scarlet lines; *sapoto*, cultivated at Coromandel, Kawhia, and Waikata, glossy leaves rather red at the edge, having a general orange green appearance; *sarariki*, a species of very fine and soft texture used for making ornamental mats, the leaves tapering, of a dull olive green. There are several flax mills in New Zealand, principally in Auckland, used chiefly for dressing the flax for rope making. Here the green leaves are stripped by revolving rollers with projecting beaters travelling at a high rate of speed, these crush the epidermis against a fixed plate so arranged as to allow room for the fibre to remain intact. The fibre thus freed from the leaf of the plant is washed by various methods, put on the ground or on lines to dry and bleach, finished by an arm or barrel scutch, and when boiled is ready for market. All the machines used are identical in principle, and vary only in the details by which the principle is carried out. This principle is that the leaf is held between horizontal feed rollers, revolving at a certain speed, while as the leaf passes out from them, a drum, armed in its circumference with iron beaters, and revolving more rapidly than the feed rollers, strips the epidermis and tissues away from the fibre, means being provided for adjusting the beating drum to a proper distance from the roller or bar against which the phormium leaf is stripped, so that the leaf may neither, on the one hand, pass through without being crushed, nor, on the other, have the fibres cut. The method of preparing fibre by machinery is a great improvement over that pursued by the Maoris, as regards the quantity produced, as they do not obtain from each leaf one-fourth of the quantity which is obtained in machine dressing. The natives cut off the leaves about six inches below the point where the two blades adhere together, and reject the coloured edges; they also take much time and pains in preparing the leaf, often soaking it for four or five days in running water, and then beat it with a stone or mallet. This process is repeated over and over again for four or five weeks. Consul Griffin states, however, that the fibre dressed by the natives is far more valuable and beautiful than that prepared by machinery. The principal competing fibre with *Phormium tenax* is Manilla hemp. This is made from a species of plantain, called *Musa textilis*, which is planted generally on the slopes of hills, and requires shade and plenty of moisture. The trees are planted about eight feet apart, and are cut down at the end of the third year, and made into fibre. A full-grown tree is estimated to yield about one pound and a-half of hemp. The process of manufacture is as follows:—The tree is cut down and stripped of its linings; these are then cut into pieces three or four inches wide, after which they are drawn underneath an instrument resembling a saw fixed in a block of wood. The fleshy part of the cortex is scraped off, and the fibre alone remains, which is then placed in the sun to dry. Two persons, one engaged in cutting down the trees and stripping them, and the other in extracting the fibre, can work up about 25 pounds of hemp in one day. The value of *Phormium tenax* exported from New Zealand, in the year 1880, amounted to £16,267.

WILLIAM SHIPLEY.

The foundation of the Society of Arts was mainly due to the exertions of William Shipley, a drawing-master, of Northampton, and his claims to this distinction was acknowledged by the award to him of a gold medal "for his public spirit which gave rise to the Society." His portrait, painted by Richard Cosway, and presented by the painter, is in the possession of the Society, and has the same inscription. When the Society was founded, in 1754, Shipley undertook to act as secretary and treasurer for one year, without payment. He subsequently held the office of registrar, which he continued to fill until 1760. Little is heard of him, after that date, in connection with the Society, and it appears that in 1768 he settled at Maidstone, where he spent the remainder of his life. At this date Lord Romney was President, and it seems probable that the connection of Shipley with his Lordship, whose country seat was at the Mote, Maidstone, induced him to go to that place. Soon after his settlement there Shipley interested himself in the formation of a Kentish Society for the promotion of useful knowledge, and to some extent he seems to have taken the Society of Arts as his model. One principal object of the Kentish Society was to assist improvements in agriculture, but subjects connected with mechanics and household economy were also dealt with. In 1783 a very practical benefit to the community was obtained by the action of the society. A malignant fever broke out in the county prisons, when seventy prisoners were effected, fifteen of whom died within a few days. The society, urged on by Shipley, investigated the causes of this outbreak, and directed their efforts towards improving the ventilation of the buildings. They raised a fund of £350 to enable them to carry out experiments, and the result was that in a short time the disease was rooted out. At the next Kent assizes, the grand jury publicly thanked Shipley and his coadjutors for their humane exertions; and the prison-surgeon, Thomas Day, published a treatise, in 1784, describing the remedial measures which had been so successfully adopted. In 1787, the Society offered a premium of ten guineas "for the best common map, and a corresponding subterraneous map of any estate in the county of Kent, with a register giving an account of the thickness and contents of the different strata." This is of interest, as showing the attention given to stratification at that date. It was not until 1815 that the Society of Arts adjudged a premium of fifty guineas to William Smith (usually known either as "Strata" Smith, or as the Father of Modern Geology), for his mineralogical map of England and Wales, in which is pointed out "the situation of the different strata of coal, lime, iron, stone and other mineral products, and the cheapest means by which these useful articles may be brought to market."

Shipley died in 1803, at the great age of 89, and a handsome monument was erected to his memory in the north-west corner of All Saints' churchyard, Maidstone. He appears to have been animated with a love for scientific investigations, which he had the ability to lead to practical issues, so that when he left London and the Society of Arts, he continued the good work he had commenced there, by uniting the most influential inhabitants of the county town of Maidstone into a society for the purpose of improving useful knowledge. He ranks among the worthies of Kent, and is so treated in Russell's "History of Maidstone," from which these particulars are chiefly taken.

THE CONDITION OF AGRICULTURAL LABOURERS IN ROMAGNA AND EMILIA.

The following account is taken from the report of the Agricultural Committee appointed to examine into the condition of the peasantry of the provinces of Romagna and Emilia. In these districts the cultivators of the soil may be divided into four classes:—Peasant proprietors; *metayers;* yearly labourers, or *boari;* and day labourers.

The peasant proprietors, who are numerous, are found almost exclusively in the region round the Appenines, where the land is greatly sub-divided, the cultivation exhausted, and in consequence the proprietors are unable to supply the wants of their families; the houses are little better than cabins, roughly built of stone, small, ill-ventilated, and black with smoke. The food consists chiefly of Indian corn and chesnuts, with very little mutton, and no wine, and habitual emigration for two or three years to France, England, or Germany.

This gloomy picture assumes an even darker tint in Valtaro, where the taxes in some communes are equal to half the gross return of the land, so that the peasant proprietors are reduced in bad years to eke out their food with wild herbs, roots, and even acorns.

The *metayers* may be divided into several classes. In Bologna we find them, as in Tuscany, dividing the produce, and not the taxes. In the other provinces of Romagna, Ravenna, and Forli, they divide both produce and taxes; whilst in Parma, Reggio, and Modena, the *metayer* takes less than half his produce.

The condition of the *metayers* in Bologna does not appear to differ from that of the same class in Tuscany; they live in good houses, have varied and sufficient food, with a little wine and beef on *fête* days. The *metayers*, who have to pay part of the taxes, are less well off, and those called the *parziari*, who take less than half the produce, are still in a worse condition, as their share has a constant tendency to be reduced by competition, whilst their scanty food consists of little else but Indian corn.

The worst feature of this district, according to the report, is the constant tendency to make the bargain harder for the peasant, whose condition is thus gradually changing for the worst.

The *boari* are labourers with a fixed yearly wage, paid sometimes in money, sometimes in money and kind, and sometimes by a share of the produce. The most usual form of contract made with them in the district of Ferrara, and in the plains of Parma and Reggio, is one that deals, generally speaking, only with the lighter and less important part of husbandry. The condition of this class of labourers is similar to that of the *parziari*, their food consisting chiefly of Indian corn, with a little wine for the heavy summer work. As their wages are paid by the year, they do not suffer from the uncertainty of the season; but in the plains they frequently may be found living in huts with walls of earth, thatched with reeds or straw.

As to the day labourers, their condition may be gained from the state of their houses, which are the most squalid and unhealthy in the district. Everywhere they are crowded together regardless of sex, huddled in small, damp rooms, the floor of which is often below the surface of the ground. The wages average 1·20 lira per day in the summer, and one lira during the rest of the year; but the report does not state whether there is sufficient work to keep the labourer constantly employed.

With reference to the sanitary condition of the country, the returns made by the Minister of Agriculture are very unsatisfactory. In every 1,000 of the agricultural population the report gives 46 sufferers from *pillagra* in Parma, 10 in Reggio, 15 in Modena, 55 in Ferrara, 16 in Bologna, 2 in Ravenna, and 6 in Forti.

When we turn to the moral condition of the people, we find that it improves with their physical condition, the *metayers* being at the top of the scale, and the day labourers at the bottom.

The mental condition of the rural population of Emilia and Romagna offers problems no less perplexing than does their physical state. In the mountain districts we find miserable peasant proprietors, then *metayers*, then yearly labourers, whose contract presses each year more hardly upon them; above all, and in the plains, we have the class of day labourers, whose condition is still more unsatisfactory. As a result, we have the yearly emigration of the small landowners, *pillagra*, and general bad sanitary condition.

NATAL COAL-FIELDS.

A report on the coal-fields of Klip River, Weenan, Umvoti, and Victoria counties, by Mr. Frederic W. North, has lately been published. Mr. North states that the questions which he kept before him in making this investigation were, "will this coal, the produce of the colony, be of any service for locomotive purposes, and if so, what is the quantity to be relied upon; and, further, what will be the pecuniary annual advantage derived by the Colony, providing the colonial fuel can be used instead of imported coal?"

The author, in concluding his report, draws special attention to the following points:—

1st. To the fact that coal exists in Klip River county, that there are several qualities, and that the workable seams vary from four to ten feet in thickness. That both analysis and experiment have now proved that the coal may be used with economy in the locomotive. Some of the most free-burning will make gas; most of it, if properly mined, will make good house-coal, and some of it is specially adapted for general steam purposes.

2nd. That the area of the coal-field available for working is 1,350 square miles.

3rd. That this area, assuming an average thickness of four feet, and allowing the ample deduction of 50 per cent. for faults, worthless coal, and barren ground, contains 2,073,000,000 tons.

4th. That a large proportion of these coal deposits are either in Crown lands or upon farms, the land of which has been disposed of, but the right to work coal reserved to the Government.

5th. Railway communication for the economical distribution of the produce of this isolated coal-field is absolutely needful, if it is to have any chance of development.

6th. The explorations for coal in either Weenan, Umvoti, or Victoria counties have, until the date of this report, only revealed unimportant indications.

7th. In the hope of finding workable coals in either of the counties, I strongly advise that a series of deep borings are systematically made by the Government, and I would advise that the first of these borings should be at a point near the mouth of the Umblanga River, and that the next should be immediately beneath the cliff, at Morewood's-cove.

8th. The information given in the tabulated sheet of analysis and experiment, is intended for the earnest consideration of all who are earnestly disposed to seriously study the important question that I have endeavoured to make so plain that "they who run may read," and I am willing to hope that some means may be devised by which the best and nearest coals to the South African coast will be placed in communication with it. I am also willing to hope that the quality and nature of these coals when collieries are fully at work upon them, will be so much better than the samples I had to dig from every outcrop, that my estimate will be found to be beneath instead of above their actual value.

Obituary.

William Stanley Jevons, F.R.S.—The sudden death, by drowning, of Professor Stanley Jevons, is a severe loss to science, and at the same time cause deep regret to a large circle of friends. The special studies upon which he was an authority were somewhat numerous, but besides these, he took a cultured interest in various literary and antiquarian topics as they arose. One of the last pieces of work he did was a short list of books on political economy, with notes as to their relative merits, which was printed in the last number of the *Monthly Notes* of the Library Association. His last book was "Studies in Deductive Logic," 1880. Mr. Jevons was elected a member of the Society of Arts in 1876, and in the present year he accepted the office of Examiner in Political Economy, which was offered him by the Council of the Society. He had previously acted for the Society as Examiner in Logic and Mental Science. The following particulars of his life are taken from the *Times*. He was the son of an iron merchant at Liverpool, and was born there on the 1st of September, 1835. His mother was a daughter of William Roscoe, the author of the well-known biographies of Lorenzo de Medici and Leo X. His early education was received at the High School of the Mechanics' Institution, Liverpool. At the age of 16, he entered University College, London, and matriculated with honours in botany and chemistry. From 1853 to 1858, or from his 18th to his 23rd year, he was assayer to the Australian Royal Mint, at Sydney. He published "Data concerning the Climate of Australia and New Zealand." Returning to England, he went on with his studies at University College, won various distinctions, and took the degree of M.A. In 1866, after becoming Fellow of his college, he was made Professor of Logic and Philosophy and Cobden Lecturer in Political Economy at Owen's College, Manchester. In the meantime he published his treatises on the value of gold, the theory of political economy, pure logic or the logic of quality, and the coal question, which last attracted great attention, and practically led to the appointment of the Royal Commission. In 1869 he brought out his "Substitution of Similars the True Principle of Reasoning," in 1870, the "Elementary Lessons in Logic;" in 1871, the "Theory of Political Economy;" in 1874, the "Principles of Science," and at a later period, "Money and the Mechanism of Exchange." In 1876, he was made Professor of Political Economy in University College, London, but last year he gave up academic work altogether. During the last ten years of his life he was made an F.R.S. and an LL.D. of Edinburgh. His chief works were the "Principles of Science," and the "Theory of Political Economy." In the former a system of logical inference akin to that of Boole is elaborated. To this should be added that his "logical machine" for solving logical questions mechanically, invented between 1863 and 1870, was exhibited to the Royal Society on 25th January, 1870. Mr. Jevons was staying with his family at St. Leonards, and his death occurred while bathing at Bexhill, near St. Leonards, on Sunday morning, the 13th inst.

General Notes.

AMSTERDAM INTERNATIONAL COLONIAL AND GENERAL EXPORT EXHIBITION, 1883.—The erection of the building intended for the Exhibition is making rapid progress, and the ground taken in for it covers about 70 acres, which involves much outlay in piles for the foundation, filling up canals, &c. The following honorary committee has been formed for Great Britain:—Sir J. Whitaker Ellis, Bart., Lord Mayor; Sir Reginald Hanson, Alderman and Sheriff of London; Sir W. A. Ogg, Sheriff of London; Lord Alfred S. Churchill; Lord Reay; Lord Thurlow; Right Hon. Lyon Playfair, C.B., F.R.S., M.P.; Sir H. Drummond Wolff, G.C.M.G., K.C.B., M.P.; Sir R. Alcock, K.C.B., D.C.L.; Sir P. Cunliffe Owen, K.C.M.G., C.B., C.I.E.; Sir Penrose G. Julyan, K.C.M.G., C.B.; Sir Edward W. Stafford, K.C.M.G., C.B.; Sir Donald Currie, K.C.M.G., M.P.; Sir F. D. Bell, K.C.M.G.; Sir Saul Samuel, K.C.M.G.; Sir Daniel Cooper, Bart., K.C.M.G.; Sir Charles Clifford, Bart.; Sir J. C. Lawrence, Bart., M.P., J.P., Alderman; Sir George C. Birdwood, M.D., C.S.I.; Sir Henry Barkly, G.C.M.G., K.C.B., General Sir H. C. Daubeney, K.C.B., J.P., James A. Youl, Esq., C.M.G., Arthur Hodgson, Esq., C.M.G., Mr. W. Walker, Mr. S. W. Silver, Mr. Frederick Young, Hon. Secretary (Members of the Council of the Royal Colonial Institute); Mr. R. Murray Smith, Agent-General for Victoria; Mr. Thomas Archer, Agent-General for Queensland; Jonkheer J. W. May, Consul-General for the Netherlands; and Mr. Hyde Clarke. The applications for space from foreign countries and the colonies are already numerous. France demands a large space, Belgium 40,000 feet, Germany will occupy an enormous space, as it did not exhibit at the last Paris Exhibition, and India, Victoria, and several of the other Australian Colonies, Jamaica, British Guiana, Trinidad, &c., intend to exhibit. The offices of the British Commission are at 35, Queen Victoria-street, City, where application for space should be made to P. L. Simmonds, British Commissioner.

NEW SPECIES OF COTTON-PLANT.—A new sort of cotton-plant is now attracting much attention in Georgia, and bids fair, it is stated, to prove immensely valuable. For many years experiments have been made with the view of hybridising the cotton-plant growing wild in Florida with the common okra. The cotton-plant used is of the species found on the lowlands of the Caloosahatchie River. The new plant retains the okra stalk and the foliage of the cotton. Its flower and fruit, however, are strikingly unlike either cotton or okra. The plants have an average height of two feet, and each plant has only one bloom. This is a magnificent flower, very much like the great magnolia in fragrance, and equally large. Like the cotton bloom, the flower is white for several days after it opens; then it becomes first a pale pink, and gradually assumes darker shades of this colour, until it becomes red, when it drops, disclosing a wonderful boll. For about ten days this boll resembles the cotton boll, and then its growth suddenly increases, as if by magic, until it finally reaches the size of a big cocoa-nut. Not until it reaches this size does the lint appear. Then its snowy threads begin to burst from the boll, but are held securely in their place by the okra-like thorns or points that line the boll. One inexperienced picker can easily gather 800 lb. a day, and fast hands a good deal more.—*St. James's Gazette.*

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Proceedings of the Society.

CANTOR LECTURES.

HYDRAULIC MACHINERY.

By Professor Perry.

Lecture I.—Delivered March 6th, 1882.

Hydraulic machines are very wonderful to people who observe their action for the first time. Here is a model of the common hydraulic press, and with this little model a labourer, without any other help, can raise a load of 100 tons, which is the weight of a long railway train. If you go to any large docks, you will see how, by the manipulation of a few handles, a boy can lift heavy weights rapidly from ships, placing them on the dock. Visit any large steel works, and you will see great armour plates and great Bessemer converters and their appliances passed about nearly as readily as small objects are moved by a village blacksmith or a brass-moulder. Visit the Victoria Docks, and you will see the largest ships raised out of the water on a floating gridiron, and towed off for repairs. Visit the River Weaver, in Cheshire, and you will see sections of a canal rising and falling with canal boats. Instead of bringing a boiler or iron girder near a rivetting machine, Mr. Tweddell takes a little rivetting machine to the boiler or girder, and works it through small flexible pipes from a distance. Think of centrifugal pumps which discharge 100,000 gallons per minute, or those of smaller size, which, worked by their little steam-engines, would keep the leakiest ship afloat: of those insignificant little machines called turbines, which make up in speed for their small size, and whose development is really in the future when electricity shall have become a handmaid of industry.

The wonder with which we look on hydraulic operations for the first time soon passes away, but I want to impress upon you the fact that this does not imply a knowledge by the general public of the nature of the action of water in these cases.

With few exceptions, the general public are utterly ignorant of the properties of electricity. People say that, when electricity is supplied to every house, as water is at present, everybody will get a knowledge of its properties. This reasoning is very fallacious. From our early swimming days, we have had much to do with water. We all take sea and river voyages, and are tossed about by water. We wash in it and drink it. It is supplied to our houses in large or small quantities. In spite of all this there is a wonderful ignorance everywhere as to the properties of water.

The internal construction of an hydraulic press is shown in Fig. 1 (p. 938). The usual appearance of such a press when used for warehouse work is shown in Fig. 18 (p. 949). Three men press, each with a force, say, of 60 lbs., on the end of this lever, A. The mechanical advantage of the lever is about 20, and hence this plunger, C, is pressed downward with a force of 3,600 lbs.

Just consider for an instant what is the condition of things before the labourers act on the lever. Here is a ram, B, which carries a heavy weight, the weight to be lifted. Observe that this ram is wanting to fall, but it can only fall into the vessel, D. Now, the space between the vessel, or press, and the ram, and all the space in these tubes, E, is filled with water, which has no means of getting away. It might get away by this little valve, F, but that the valve can only open inwards, and the more the water tries to escape, the more it really closes the valve, just as a closely-packed crowd in a panic keeps an inward-opening door closed, by which they might otherwise escape from a theatre. There is no escape for the water anywhere on the pump side, and there is just as little on the other side, for you see that the water if it escapes into the space N, finds that it has still to get past the leather, which is, however, so placed and shaped that the greater the water pressure the tighter the leather fits the ram. Fig 6 (p. 942) is a specimen of such a leather collar.

There is, then, no escape for the water, and when this is the case, no matter what weight is placed on the top of the ram, it cannot fall. The falling of the ram would mean some escape for this water; but as there is no escape for the water, the ram will fall no more than if it were supported on some quite rigid material.

I have been supposing here that a certain quantity of water will absolutely refuse to occupy a smaller space, but this is not quite correct. You know that if it were air that filled this space, D, instead of water, and there were no escape for it, the ram would fall when a greater weight was placed on it; for although the air cannot escape, it is contented to occupy a smaller bulk. I have been supposing that this does not occur in water, and that water will refuse to go into a smaller space, whatever the pressure. This was an old notion which people deduced from the famous Florentine experiment. A hollow globe of gold was quite filled with water, and was hermetically sealed. It was then beaten to diminish its cubic contents, and the result was that drops of water made their appearance on the surface, having oozed out through the pores in the gold, rather than submit to the lessening of the total bulk.

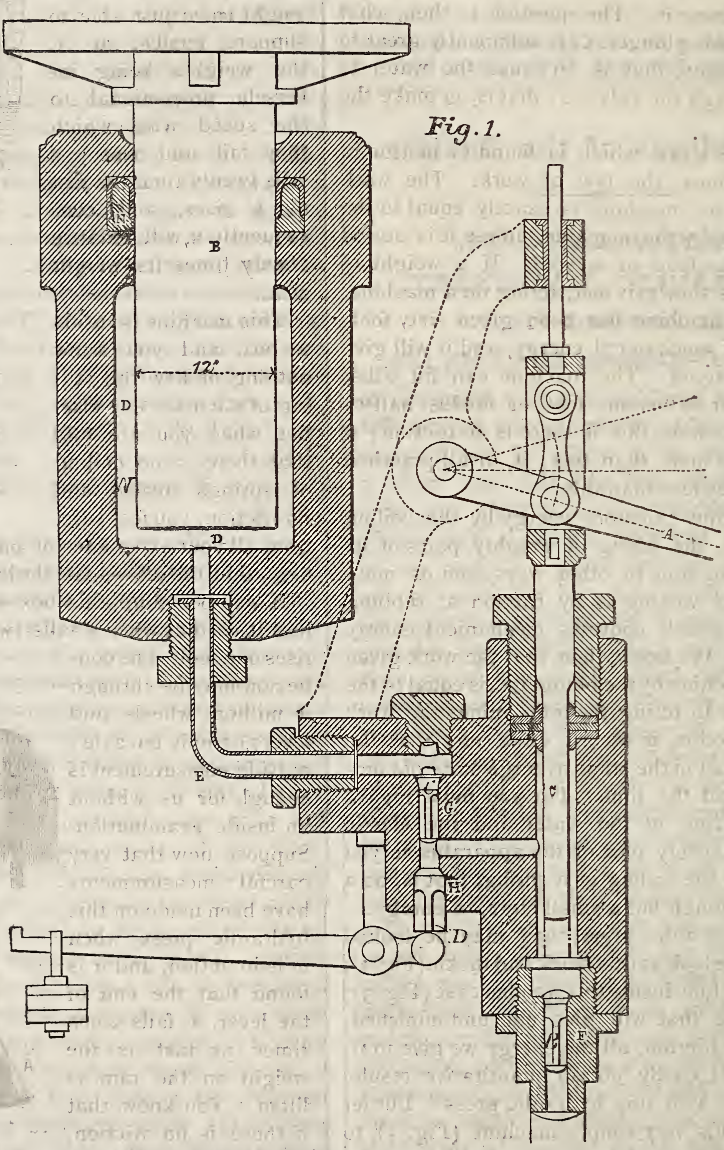


Fig. 1.

Mr. Roe tells me that a friend of his, in illustrating lectures given to the Royal Engineers at Chatham, pressed the water inside a cast-iron shell so much, that it came through the pores of the iron, and appeared as a fine spray or mist on the outside, and soon afterwards the shell burst, or rather fell gently in pieces. But, with a piezometer, it is easy to show that water and all other substances will submit to a diminution of their bulk when subjected to pressure; and we find that this diminution for water is 1-20,000th of its total bulk for a change of pressure of one atmosphere, or 1-70th of its volume for a pressure such as we find in hydraulic presses. Now this diminution in bulk is far too insignificant to be of much practical importance in hydraulic machines, and we may take it for granted that whatever weight he placed on this ram, it will not perceptibly fall, because the water refuses to become smaller in bulk, and because it cannot escape anywhere.

You understand that it tries to get away; it is trying to burst this thick cast-iron press; it is trying to burst these pipes and the pump. Before it will burst the pump, it will open this safety valve, H, and escape; but we can assume for the present that the pressure never reaches the bursting pressure of the arrangement.

Now the labourer acts on his lever, forcing down the plunger. The water here is just like the water in the press, it tries to escape, it tries to burst this pump barrel, it resists the motion of the plunger. It tries to escape through the valves, F, G, and H, and it will open this valve, G, and pass through, if the labourer acts sufficiently on his lever; but if it passes through, the ram must rise, however great the weight may be above it. The question is then, what force on this plunger, C, is sufficiently great to cause motion, that is, to cause the water to pass through the valve, G; that is, to make the ram rise.

There is a law which is found to be true in all machines—the law of work. The work done to any machine is exactly equal to the work done by the machine, unless it is stored in the machine or wasted. If a weight of 10 lb. falls slowly six feet, acting on a machine, then the machine has been given sixty foot-pounds of mechanical energy, and it will give this out again. The machine can lift 6 lbs. ten feet, or 60 lbs. one foot, or 120 lbs. half-a-foot. It can do this if there is no friction; it cannot do more than this; it, in all practical cases, does less than this.

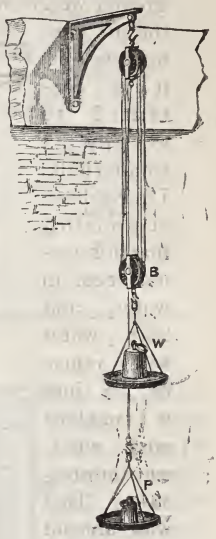
A machine can store energy by the coiling of springs, the lifting of weighty parts of its mechanism, and in other ways, and its main method of wasting is by friction at rubbing surfaces, which converts mechanical energy into heat. We know, then, that the work given to this machine by the plunger, C, is equal to the work done in lifting the ram, minus the work lost in friction, if we are quite sure that the water is just in the same average state of compression all the time. For you must regard the squeezing of the water and the elastic yielding of every part of the apparatus as you look upon the coiling of a spring, that is, as a store, although but a small store, of energy.

This hydraulic press, then, may be looked upon as we look at this block and tackle (Fig. 2), or the machine inside this wooden case (Fig. 3); a machine that will give out undiminished, except by friction, all the energy we give to it.

I cannot easily obtain quantitative results before you with this hydraulic press. But let me take this very simple machine (Fig. 3), to illustrate my meaning.

You see that when the weight A falls, the weight B is lifted. In considering such a machine, we first find out how many feet B will fall when A rises, say one foot. Now I find that B falls 20 feet, when A rises one foot. Suppose the weight of B to be 6 lbs., in falling 20 ft. it gives to the machine 20 × 6, or 120 foot-pounds of energy, and if there is no friction in the machine, this same amount of energy is devoted to the lifting of A. Now, if A is 120 lbs., then in rising one foot, just 120 foot-pounds of energy will be consumed. We see, then, that if there is no friction in this machine, 6 lbs. at B ought to be just able to support 120 lbs. at A, the weights being inversely proportional to the speed with which they fall and rise. B falls twenty times as fast as A rises, and consequently B will balance twenty times its weight at A.

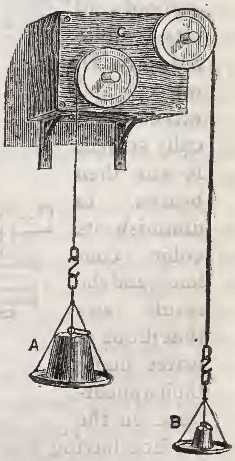
Fig. 2.



This machine is inside a box, and you know nothing of how the falling of A causes B to rise, but when you are told that there is no coiling of springs inside, and no friction, you feel sure, from all your experience of nature and machinery, that the above calculation is correct.

If we opened up this box we might find out how it is that when B falls twenty feet A only rises one foot. The connexion may be through a million wheels and levers or only one axle; outside measurement is enough for us without an inside examination. Suppose now that very careful measurements have been made on this hydraulic press when it is in action, and it is found that the end of the lever, A, falls 2,000 times as fast as the weight on the ram is lifted. You know that if there is no friction, a weight of 1 lb. at A will balance a weight of 2,000 lbs at B, and hence a weight of 180 lbs. at A will balance a weight of 360,000 lbs., or nearly 170 tons, at B. This you can tell without examining the inside of the machine. And if there is friction, what you do is this. You place

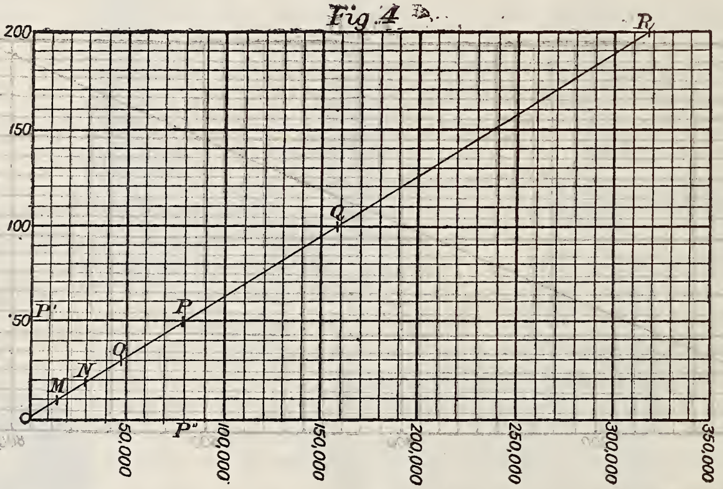
Fig. 3.



a weight of 10 lbs. at A, and find what great weight at B is just lifted slowly. You repeat this process with 20 lbs. at A, and then 30 lbs. at A, and so on, and obtain such a table as the following:—

Weight A which causes a slow motion.	B, the weight on ram.
10 lbs.	12,976 lbs.
20	28,916
30	44,996
⋮	⋮
50	77,032
⋮	
100	156,852
⋮	
200	317,121

Fig. 4



When A is 10 lbs., B is only 1,300 times as great, and when A is 200 lbs., B is only 1,586 times as great. You see now that B is by no means 2,000 times A, and you put down this loss of your mechanical advantage to friction, combined with a small useless store of energy.

Here we come to consider the great virtue possessed by squared paper. Get a sheet of squared paper like this (Fig. 4), and let a point, P, represent one of the above experimental results. Thus the horizontal distance, PP^1, represents this weight of B, 77,000 lbs., to a certain scale of representation; and the vertical distance, PP'', represents the weight of A, which just overcame it, or 50 lb. to quite another scale. In the same way each of the points, M, N, O, P, Q, R, represents the result of an experiment, and we are going to find out whether they follow any simple law.

You observe that these points all lie nearly in a straight line, and this tells us that any increase in the load, B, is balanced by a proportionate increase in the load, A. Thus if B increases by 16,000 lbs., A increases 10 lbs., so that the increase of B is 1,600 times the increase of A. The line also tells me that when there is no load on the ram, a load of 1·875 lb. at A is necessary to cause a slow motion of the machine.

In fact, I have carefully considered this sheet, and find that the load necessary at A is a force of 1·875 lb., together with the fraction $\frac{1}{1600}$th of whatever load is placed on P. This is a very different matter from the mechanical advantage that we expected to obtain, when we considered that there was no friction. In fact, we may take it that about 20 per cent. of the energy given by the labourers to the handle is wasted in friction.

Different experimenters give different results as to the loss in friction. Rankine's results were about 20 per cent. of loss; but Mr. Hick, of Bolton, in 1867, found results which were less than one-tenth of Rankine's. It is, then, very probable that there is usually much less than 20 per cent. of loss in hand-worked hydraulic presses. The law that I have here given you for an hydraulic press is exactly of the same kind as the law you get for any machine. In all simple and complicated machines, when one force, A, is just able to overcome another, B, you will find by experiment that A is equal to some number of pounds together with a certain fraction of B. You will also find that the velocity ratio is in every case quite misleading.

Thus in the note-books of my students I found results of experiments on a crane, which are given on the next page.

Plotting these numbers, as shown in Fig. 5, they obtained the law—

$$A = 4{\cdot}21 + {\cdot}0429\ B.$$

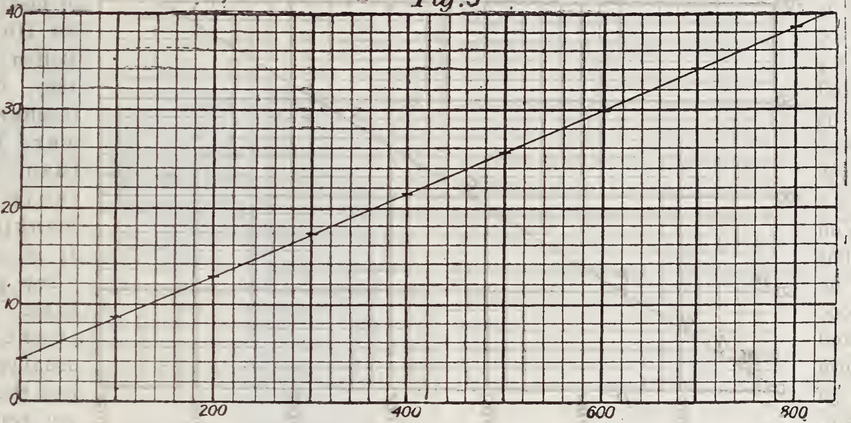
But they found that A fell 40 times more

B, weight lifted slowly.	A, weight acting on string round grooved wheel, instead of the ordinary handle.
100 lbs.	8·5 lbs.
200	12·8
300	17·0
400	21·4
500	25·6
600	29·9
700	34·2
800	38·5

rapidly than B rose, and hence, if there were no friction, A ought to lift a weight 40 times greater than itself. Thus the weight of 800 lbs. ought only to need 20 lbs. to lift it; but in the actual case it needs 38·5 lbs., or nearly twice as much. The difference, 18·5 lbs., is the increase of the force required at A, which is necessary to overcome friction. In fact, only 52 per cent. of the labour given to the machine is utilised.

You can easily find the law connecting A and B for any machine by a number of trials, and it is one of the most interesting investigations that can be made. There is not time for me to give you here the results that are known to us about machines generally, because they cannot be given simply, depending as they do on the state of the rubbing surfaces of the machines. But you may safely say that a crane seldom utilises more than 60 per cent. of the work given to it, and a fairly good crane may even utilise less than 30 per cent. A differential pulley-block, well greased, may utilise 40 per cent. of the energy given to it. A screw jack may utilise 30 per cent. of the energy given to it, but in many cases it utilises no more than 15 per cent. Hydraulic presses and jacks show generally, a utilisation of over 80 per cent. of the energy given up by the labourer.

Fig. 5



As an instance of this greater efficiency of hydraulic machines, Mr. Roe informed me that a platform weighing 12 tons had to be lifted, and one little hydraulic jack was placed under one corner, and a screw jack under the other corner. One man was told off to work the hydraulic jack, and three men to the screw jack. Our friend with the hydraulic jack, with one hand in his pocket, would pump a few strokes, and then quietly stand by for an interval, whereas the three men were hard at work with the screw jack all the time. He was able, in one-fourth the time, to do easily as much useful work as the three men were doing working their hardest.

I find on this card that, 300 years ago, Fontana raised an obelisk at Rome with 40 capstans, worked by 960 men and 75 horses 46 years ago Le Bas raised the Luxor obelisk at Paris with 10 capstans, worked by 480 men. Four years ago, Mr. Dixon raised Cleopatra's Needle in London with four hydraulic jacks, in every respect like the one which you see before you, worked each by one man.

I understand that the heaviest gun which has been manipulated by ordinary gearing is one of 18 tons. All larger guns are worked by hydraulic machinery, and on the system about which I mean to speak in my fourth lecture, there seems no reason for doubting that there is no limit whatsoever to the size of guns which can be rapidly manipulated by hydraulic machinery. Let us hope that some social frictional resistance will come in, to replace the absence of material friction in such cases.

My students in Japan used to employ a little hydraulic press, just of this size, to crush bricks, stones, and wood, and it was roughly assumed that the friction at the glands was insignificant. Of course, we only made this assumption when we wanted rapidly to get a rough idea of the relative strengths of materials to resist crushing. Still it was a sort of thing that we should not have been able to do with a screw jack.

Let us now consider why it is that hydraulic machines have so much greater an efficiency than ordinary machines. In the hydraulic press, as in any other machine, the mechanical advantage, leaving friction out of account, simply depends on the relative velocities of the plunger and the ram.

You are all well aware of how it is that wheels, screws, levers, and belts diminish or increase speed. How does the hydraulic press effect this object?

Suppose that this plunger, C, is one square inch in section, and that one inch more of its length is forced into the pump, evidently the metal takes up the place of an equal bulk of water, or one cubic inch. For you know that one inch of material, one square inch in section, contains one cubic inch. This cubic inch of space is now occupied by metal, and it used to be occupied by water, and the water has found one cubic inch of room for itself somewhere else. As we suppose no greater compression of the water, and no yielding of the sides of the press, it is evident that one cubic inch of the ram must leave the press to give the water the space it must have. Now, if the ram is 100 square inches in section, then 1-100th of an inch of its length contains one cubic inch in volume. If the ram lifts through the distance 1-100th of an inch, it will, therefore, leave one cubic inch of room behind it.

We are not concerned with the shapes of the ends of the plunger and ram; we know that if one more inch of the plunger enters the water, 1-100th of an inch of the ram must leave the water; that is, the relative speeds of plunger and ram are as one inch to 1-100th of an inch, or as 100 to 1. The plunger must move 100 times as quickly as the ram, and by the law of work, if there was no friction, a force of one pound on the plunger would balance a force of 100 pounds on the ram. We know the mechanical advantage then, if there were no friction, in the portion of this machine from plunger to ram, if we know how many times greater is the area of the ram than the area of the plunger.

So much, then, for the mechanical advantage if there were no friction.

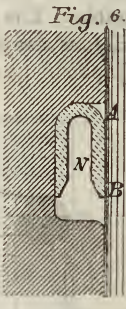
And now, where does friction occur in the hydraulic press. It occurs at

1. The rubbing surface at the fulcrum of the lever. This is the friction of solids.
2. The rubbing surfaces of the two glands; one that of the plunger, the other that of the ram. Here again we have friction, as if between solids.
3. Everywhere in the water where there is motion. This is fluid friction, which is quite different from that of solids.

You know the nature of the friction at the fulcrum of the lever, or any other mechanism required to move this plunger.

Here is a specimen (Fig. 6) of the leather collar used in presses. It is made from the best leather, softened in hot water, and pressed between cast iron moulds to its present shape, the pressure gradually increasing. It is then left for several days under pressure in the mould. The water gets behind this leather, and presses it tightly against the ram. The friction seems mainly to occur at the part A, and increases as the pressure of the water increases. Mr. Hick found that there does not seem to be much friction at the portion between A and B, and the efficiency of the press is but little altered by making A B greater or less. It is, however, asserted by some makers of presses that the distance A B is of importance; but I rather think that this is on account of deterioration. The part B A is constantly being in states of tension and compression, and is liable to crack. When the leather deteriorates, much time is wasted in renewing it.

Fig. 6.



Hemp-packing is invariably used instead of the leather collar at low pressures; some manufacturers never use hemp or cotton when the water has a greater pressure than 700 lbs. per square inch, but Mr. Tweddell and others use hemp to 2,000 lbs. per square inch.

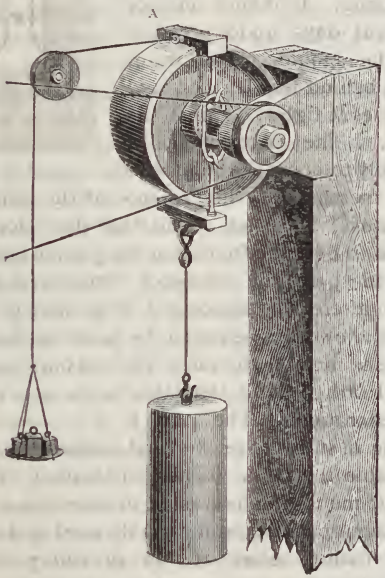
Our subject is too large to allow me to enter into many details as to the advantages and disadvantages of leather, india-rubber, and gutta-percha for packing purposes. There is a great divergence of opinion, and I believe that much of the evidence against one or another material is based on the bad preparation of the materials against which the evidence is given.

In Figs. 11, 12, and 13 (p. 946), you will see the form of india-rubber cup used in hydraulic jacks and bears. It is moulded in this form, and is fastened to the end of this ram by means of a screwed bolt and metal washer, as shown in the figure. The water pressure keeps it tight against the cylinder at the point, and this is where the friction occurs.

The friction between lubricated leather or hemp, or rubber and metal, follows the laws of solid friction, and we have now described what friction of this kind occurs in hydraulic presses. The remaining source of loss of energy is the fluid friction.

In ordinary machines the friction occurs at the rubbing surfaces of solid bodies, and such friction is proportional to the load, and is almost altogether independent of speed. If anything, it is greatest at very slow speeds.

Fig. 7.



Here is an apparatus (Fig. 7) which I designed in Japan to measure the friction between sliders, A, of all these different materials, and this cast-iron wheel, with very different loads on the sliders, and very different speeds of the wheel. You observe that the slider is at rest. and that its force of friction with the rim of the wheel is just balanced by the weight in this scale pan. The result is, that there is no great difference in the friction at different speeds, and that the friction is proportional to the load on the slider. What, then, is the explanation of the well-known curious fact about railway brakes? It is this—in experiments on railway brakes there is no true friction; the material of the brake block is rapidly worn away; thus, in one of Captain Galton's experiments, *several* inches in thickness were removed in a *few* minutes.

I do not say that the rules for solid friction given in this wall sheet are absolutely true, but they are nearly enough true for your general acceptance, and you must not think that they conflict with the laws of resistance to abrading and polishing which have been found from experiments on railway brakes.

What, now, are the laws of fluid friction? One fact is well known to everybody, namely, that water is easily changed in shape. It takes the shape of any containing vessel. A bar of steel, if placed in a vessel, would probably remain a bar for ever; it would not flow over the bottom of the vessel as water does. Now we have every gradation in character between steel and water. Steel can certainly be made to flow. It is drawn out into pianoforte wire. Many of you are aware of M. Tresca's interesting observations on the flow of metals. You have all seen copper wires drawn, and you know that many metals can be beaten or squirted out into other shapes without melting them; but, as a rule, great pressures are needed to perform these operations.

But the peculiarity of all substances which we call fluid is this, they will flow and change their shape, even when very small forces act upon them.

Thus you all observe this very rigid-looking bituminous material, which breaks with a glassy fracture. Now that material is a fluid. If I leave it piled up on this soup-plate, you will find that after some days it will have covered the bottom of the plate, and that, although it flows very slowly, it does flow, even under the influence of its own weight.

Here, again, is a stick of sealing-wax. You see that I can use it like a piece of wood to push or pull other objects with. But if I support its two ends, and leave it to itself, even its own weight is sufficient to cause a gradual bending, which is quite perceptible after a few days.

Now, between this rigid-looking black mass and this liquid-looking tar, I can obtain every gradation of fluidity, and all such substances are said to be viscous liquids. A liquid yields perhaps slowly, perhaps rapidly, but it yields to slight stresses tending to make it change its form.

Of course, water yields much more readily than any of these substances, but there is a certain amount of viscidity, which is quite measurable, and which gives rise to what we usually term friction.

If a man attempts to dive into water unskilfully, and falls prone, you know that the water offers a very considerable resistance to a change of shape. Now this resistance is not quite what I am talking about. This is mainly the resistance that any body offers to being rapidly set in motion. If you came colliding against the end of the most frictionless carriage, you would also experience its resistance to suddenly being set in motion; whereas the constant steady resistance to motion which the carriage experiences when moving with a uniform velocity is called friction.

What I am rather referring to is the resistance to the motion of water in a pipe, the resistance to the steady motion of a ship.

Fig. 8 shows a hollow cylindric body, F, supported so that it cannot move sidewise, and yet so that its only resistance to turning is due to the twist it would give this suspension wire A. C C is water or other liquid filling the space between the cylindric surfaces D D and E E, and wetting both sides of F. When the vessel D D E E is rotated, the water moving past the surfaces of F tends to make F turn round, and this frictional torque is resisted by the twist which is given to the wire. The amount of twist in the wire gives us, then, a measurement of the viscosity of liquids, and investigations may be made under very different conditions.

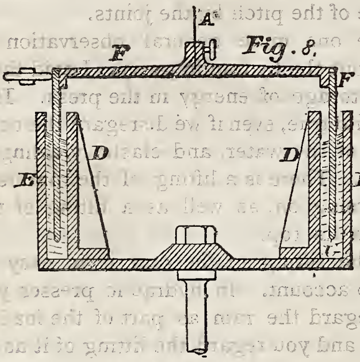


Fig. 8.

Fluid friction may be illustrated by similar and equal cylinders of brass, which you set hanging in air, water, and oil.

You will observe that, when the suspension wires are twisted and let go, the bodies vibrate like the balance of a watch. But it is only the one which vibrates in air that goes on vibrating for a long time; the one in water keeps up its motion longer, however, than the one in oil, showing that there is more frictional resistance in oil than in water, and in water than in air.

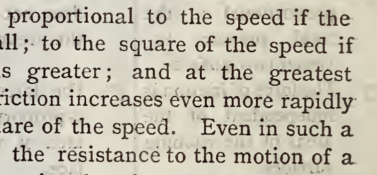
The rate of diminution of swing tells us the viscous friction of the fluid. Similarly, the rate of diminution of swing of the vibrating fluids in two U tubes, one containing water and the other oil, tells us about the relative co-efficients co-efficients of viscosity of the liquids.

From experiment, it is found that the force of friction in water is proportional to the wetted surface where friction occurs; it is proportional to the speed, if the speed is small, but it increases much more quickly than the speed does. Thus, at the velocities of 1, 2, 3, &c., inches per second, the friction is proportional to the numbers 1, 2, 3, &c., whereas, at the velocities of 1, 2, 3 yards per second, the friction is proportional to the numbers 1, 4, 9, &c. At small velocities such as these cylinders experience, three times the speed means three times the friction; whereas, at great velocities, such as those of ships, three times the speed means nine or more times the friction. You see, then, that friction in fluids, is proportional to the speed if the speed is small; to the square of the speed if the speed is greater; and at the greatest speeds the friction increases even more rapidly than the square of the speed. Even in such a fluid as air, the resistance to the motion of a bullet is proportional to the cube of the speed. That is, a bullet of twice the velocity meets with eight times the frictional resistance from the atmosphere.

Again, it has been found that the friction is much the same whatever be the pressure. Thus it is found that when this cylinder apparatus and water are placed in the receiver of an air pump there is exactly the same stilling of the vibrations.

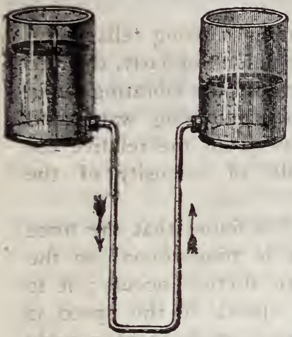
Here is an apparatus (Fig. 9), which illustrates the fact. Water tends to pass from vessel A to vessel B by means of this long tube. Whether the tube is in the position M, or N, we find the same flow through it, the same quan-

Fig. 9.



tity of water passes through it per second; although, as you see, the pressure of the water in the tube in the position N is very much greater than in the position M.

Fig. 10.



POSITION N.

Again, fluid friction, for even considerable velocities, does not seem to depend much on the roughness of the solid boundary. The wall sheet compares fluid friction and the friction at rubbing surfaces of solids.

Friction between Solids.	Fluid Friction.
1°. The force of friction does not much depend on the velocity, but is certainly greatest at slow speeds.	1°. The force of friction very much depends on the velocity, and is indefinitely small when the speed is very slow.
2. The force of friction is proportional to the total pressure between two surfaces.	2°. The force of friction does not depend on the pressure.
3°. The force of friction is independent of the areas of the rubbing surfaces.	3°. The force of friction is proportional to the area of wetted surface.
4. The force of friction depends very much on the nature of the rubbing surfaces, their roughness, &c.	4. The force of friction at moderate speeds does not depend on the nature of the rubbing surfaces.

You see now that in a hydraulic press, where the flow of water is everywhere slow, there cannot be much loss on account of fluid friction. Whatever loss there is must occur in these narrow passages, where the velocity is more considerable than in the press. But the grand distinction between it and other mechanisms lie in the fact that, when the motion is extremely slow, the fluid friction is extremely small.

The friction at the fulcrum of the lever we know about. The friction at these glands is simply due to the fact that metals rub on leather or hemp, and the pressure between the rubbing surfaces being proportional to the load, the quasi-solid friction is also proportional to the load. It is the friction at these two stuffing boxes or glands which makes up the loss of power in all such machines as I am speaking about. For in all the machines which I am speaking about to-night, the water velocity is small, and the water friction can be neglected.

So small indeed is the fluid velocity, that when oil is used, the loss would be much the same. Probably honey or tar would not give very different results; but the more viscous mixtures of tar and pitch would be unsuitable, because in these the fluid friction, at even such small velocities as we have to consider, would be considerable. I want you, however, to recognise the fact, that even solid pitch would act as a fluid in the hydraulic press; but to obtain the same mechanical advantage as with water, you would require not to make more than one stroke of the plunger per month, and you would need to take exceptional precautions as to escape of the pitch by the joints.

I have one more general observation to make about the hydraulic press. I said there was no storage of energy in the press. This is not quite true, even if we disregard the compression of the water, and elastic yielding of the press. There is a lifting of the ram itself always going on, as well as a lifting of the weight on its top.

Now the lifting of the ram it is easy to take into account. In hydraulic presses you simply regard the ram as part of the load to be lifted, and you regard the lifting of it as an absolute waste of a not very large kind.

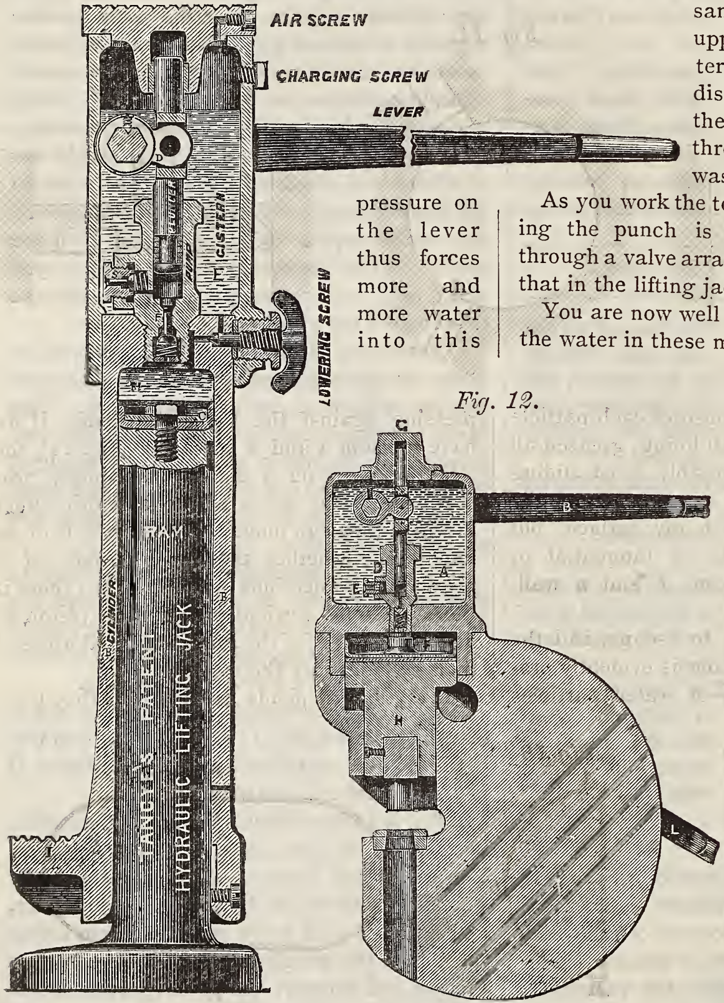
But when the weight lifted by the ram is less than the weight of the ram itself, and this is the case in warehouse and hotel hoists, it is usual to take it into account.

But it is rather difficult to take into account, because as it rises its weight gets greater. You know that a stone, when surrounded by water, is easier to lift than when it is in the air, and as more and more of a long ram leaves the press, the weight of the whole ram gets greater and greater, just in proportion to the weight of the water which it displaced.

I say that in hydraulic presses we can leave this out of account, but we cannot do so in hoists. In a future lecture I shall tell you how Clark and Standfield's balance method, applied to lifts, enables us to get over the difficulty.

The section of one of these lifting jacks you see in Fig. 11. Here the ram fits the pump-barrel, and is made water-tight by the india-rubber dish, C, fastened round the top of the ram by a screw. Now the motion of the working lever causes great pressure on a projection of the shaft D, which communicates with the plunger of the pump, and gives it a downward motion, pressing the water in the pump-chamber E through the valve F, into the reservoir H, where it presses against the ram, which is firmly fixed. A small pressure on the lever thus forces more and more water into this water-tight reservoir, and necessitates the upward movement of the outer cylinder B B. Thus the claw I lifts any weights that may be resting on it. The upward motion of the lever causes a partial vacuum in the chamber E, as the plunger is withdrawn, and the air screw being slackened, the pressure of the air and liquid in the cistern overcomes the resistance of the spring on the inlet valve S, raises the valve, and thus effects a passage for the water into chamber E. During the downward stroke the previously-described operation is repeated. If we want to lower the weight we open the lowering screw, and allow the water to return from the top of ram to the cistern.

Fig. 11.



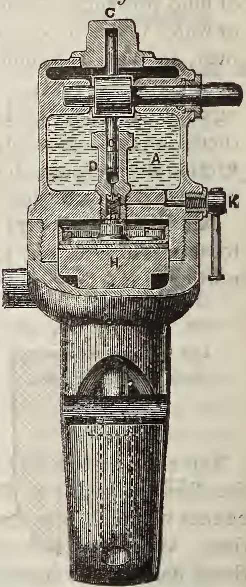
The punching-bear, of which you have sections in Figs. 12 and 13, is similar in construction. The plunger, pump, valves, &c., are much the same as in the last case. The upper part of the stout ram H terminates in an india-rubber dish, which is fastened by the washer and a bolt passing through the middle of the washer from the ram.

As you work the top lever B, the ram H holding the punch is pressed down by water through a valve arrangement exactly similar to that in the lifting jack.

You are now well aware of the way in which the water in these machines acts. It is nearly incompressible, and tries to find an outlet in every direction. Try to bring your minds down to the consideration of what occurs from particle to particle of the water. Each particle presses on all its neighbours, because they all press in upon it, and it presses equally in every direction.

Fig. 12.

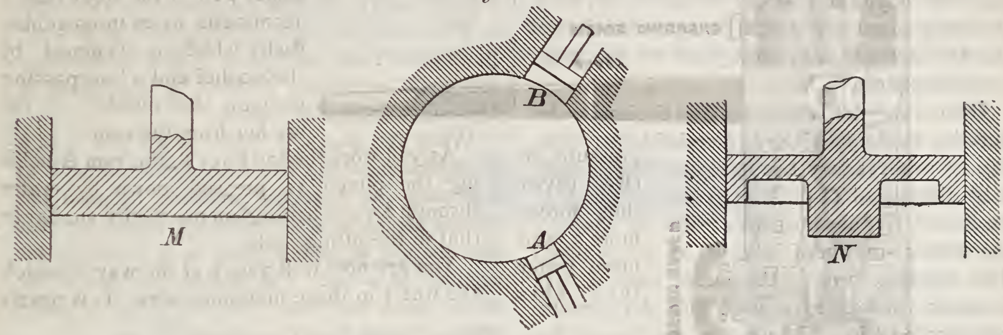
Fig. 13.



Wherever the water comes in contact with a solid surface, it presses against the surface, and the direction of this pressure is directly normal. There can be no such thing as oblique pressure in water when the water is at rest, for oblique pressure means a force partly along the surface, and this would imply some frictional resistance to sliding, which we know cannot occur in water at rest. It is evident from our discussion of the hydraulic press as a machine in which there is no store of energy, that on every square inch of the solid surface touched by the water there must be the same force acting, the water tending to escape everywhere; and when we consider the whole case mathematically, we find that every little interface separating any two portions of water is acted on by this same pressure per square inch. You will, perhaps, some of you, have been troubled by the notion that the shape of the end of the ram ought to have some effect on the total force with which the ram is pressed upwards.

You will be perfectly safe in all your notions of fluid presence, if you consider each particle of water to be a very small being, greased all over, so that it cannot possibly resist sliding past its neighbours. It can press normally against a wall, or against any surface, but there cannot possibly be a tangential or frictional pressure between it and a wall, because it is well greased.

Fig. 14.



All the water is trying to escape, and the total pressure on any surface is evidently proportional to the number of water particles pressing against the surface. Hence, if we have a piston A and a piston B (Fig. 14), the total pressures on A and B, are simply proportional to the areas of the cylindric tubes in which they can move. Evidently it is of no importance whether the inner surface of a piston has projections or not. Thus there is the same total vertical pressure on piston M, and on piston N, if the cross sectional areas of their cylinders are the same.

Everything depends on this, will they leave the same empty space behind them, if each of them moves one inch, and we know that in each case the empty space is simply one inch, in length of the cylinder.

Fig. 15.

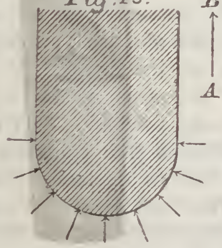


Fig 16

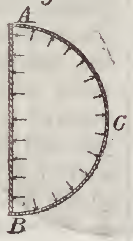
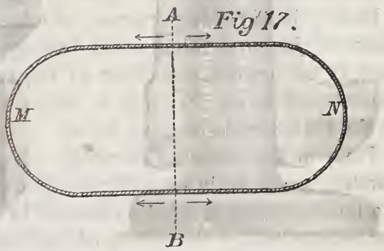


Fig 17.



In the same way, although the end of the ram may be curved, as we see in Fig. 15, and it is therefore being acted on by a series of pressures, as in the figure, it is easy to show that the resultant action of these in the direction A B, is really the same as if the ram had a flat end. Every one of these forces has a horizontal tendency, more or less, and when we leave out of account these horizontal actions, we get the same vertical result for all shapes of ends.

You will understand this better, perhaps, if we consider a vessel, A, B, C (Fig. 16), to be filled with fluid at such a great pressure, that we can neglect the pressure due to the fluid's own weight. This we can do in the hydraulic press and in steam boilers. The pressure on the surface everywhere is shown by the arrows.

Now it is evident that the total horizontal force on the curved surface A, C, B, is exactly equal and opposite to the total horizontal force on the flat surface, A, B, because if there were on the whole more force on one than the other, the vessel would move bodily, an idea which is absurd. Hence, when we want to find the total horizontal force on the curved surface, we never dream of going into the long calculation which you might think necessary, for it is simply equal to the area in square inches of the flat surface, A, B, multiplied by the pressure per square inch.

Hence, suppose we want to find the horizontal bursting tendency of the egg-ended boiler, M, N, Fig. 17; that is, say, the force tending to burst it by direct pull of the iron at the section A, B, we do not trouble ourselves with the shape of the boiler anywhere except at A, B itself. The bursting force is the inside area of A, B, in square inches, multiplied into the pressure per square inch. The area of the iron in the section A, B, is exposed to this pull. These are the two important facts to be remembered. Consider any section whatsoever of a boiler, or ram, or pipe. Remember that the fluid pressure is calculated over the whole area. The resistance of the iron is only calculated over the actual sectional area of the metal.

Thus, if we want to find the tendency to burst along such a section as M, N, we take the total inside area of the section here multiplied by the pressure, and this is equal to the stress in the iron all along this section, multiplied by the whole sectional area of the iron.

In a cylindric boiler or press, which is everywhere of the same thickness, it is easy to show that, if we neglect the effect of the ends, the tendency to burst laterally is twice as great as the tendency to burst endwise.

Thus in the endwise bursting. If p is the bursting pressure in pounds per square inch, f the tensile strength of the material in pounds per square inch, r the radius of the boiler, and t, the thickness of metal, the total force tending to produce bursting is the area of the circular cross section, $3{\cdot}14\ r^2$, multiplied by p, and the total force resisting fracture is the circumference of the circular cross section, $6{\cdot}28\ r$, multiplied by t and by f. Hence—

$$3{\cdot}14\ r^2\ p = 6{\cdot}28\ r\ f\ t.$$

or the bursting pressure $p = 2\ f\ t \div r$.

Again, if a boiler is l inches long, the total force tending to burst the boiler is the area l times the diameter of the boiler, multiplied by p, or $2\ r\ l\ p$, and the total force resisting fracture, if we neglect the ends, is the area of the iron $2\ l\ t$, multiplied by f. Hence—

$$2\ r\ l\ p = 2\ l\ t\ f,$$

or the bursting pressure $p = f\ t \div r$.

Hence it would take twice as much pressure to burst the boiler, if we assumed it to burst endwise. We always calculate the strength of a pipe or boiler on the second assumption therefore, and we have the rule:—The bursting pressure in pounds per square inch is equal to the tensile strength of the metal in pounds per square inch, multiplied by the thickness of the metal in inches, divided by the radius of the boiler or pipe in inches.

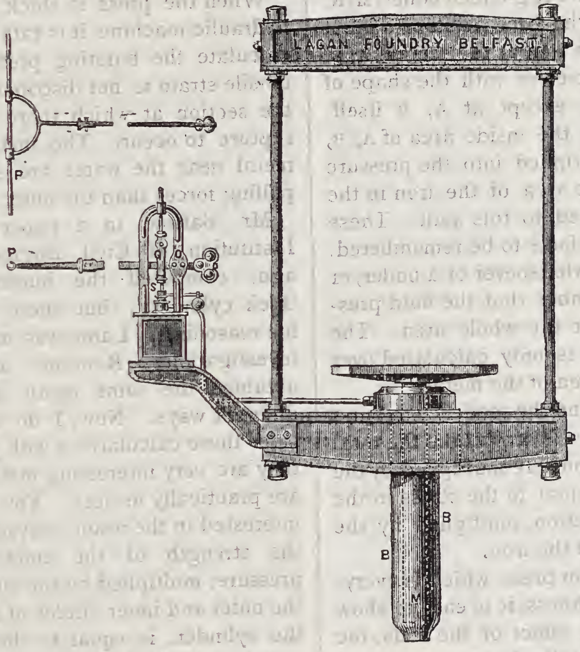
When the press is thick, as we find it in a hydraulic machine, it is rather more difficult to calculate the bursting pressure, because the tensile strain is not distributed uniformly over the section at which there is a tendency for rupture to occur. The inside portions of the metal near the water are subjected to more pulling forces than the outer portions.

Mr. Barlow, in a paper read before the Institution of Civil Engineers, some years ago, computed the bursting pressure of thick cylinders; but there was a defect in his reasoning. Lamé was more correct in his investigation. Rankine and others have obtained the same result as Lamé, but in different ways. Now, I do not mean to consider these calculations with you, for although they are very interesting mathematically, they are practically useless. You may, however, be interested in the result arrived at. Neglecting the strength of the ends:—The bursting pressure, multiplied by the sum of the areas of the outer and inner circles of a cross section of the cylinder, is equal to the strength of the metal multiplied by the area of the metal exposed in such a cross section. This rule you will find applicable to thin cylinders as well; it is the same rule as the one already given. You see that if the fluid pressure is equal to the tensile strength of the metal, no thickness of the cylinder can prevent its bursting.

The investigation might perhaps have some use if iron, when it leaves the foundry, had all through its thickness the same qualities and a perfect absence from strain. It is good to remember that an iron casting, when it leaves the foundry, although not quite so curiously strained as a Prince Rupert's drop or toughened glass, is yet in a state of strain which we know very little about.

The above investigation shows that in a thick cylinder there is an exceedingly great difference in the tensions of the inner and outer portions of the metal of a gun or hydraulic press. For the purpose of producing a more uniform state of stress, the inside portions of the metal are often chilled; that is, the metal in the inside is very quickly cooled after it is cast. The result is that these portions are virtually in a state of great compression, and hence, when the regular strain occurs through water pressure, there is a considerable tensile yielding in the inner portions of metal before the bursting tensile stress is reached there; and hence, with a proper amount of chilling, it is possible to have the tensile stress in the metal nearly uniform when fracture is ready to occur. In such a case as this, the calculation of the bursting pressure of a press is just the same as if it were thin.

Fig. 18.



Cast-steel is now getting common for the cylinders of small jacks and bears. The large presses used in warehouses are, however, still made of loam-moulded cast-iron, as all presses used to be in my apprenticeship days. But in a great deal of large press-work cast-steel has come largely into fashion, its tensile strength being so much greater than the strength of cast-iron as to make a most extraordinary difference in the outside sizes of the cylinders. Thus, for example, in a Wilson-Cotton press, it enabled three cylinders to be placed side by side in a space which would only have allowed one to be used if it had been made of cast-iron.

In this drawing, Fig. 18, you see an hydraulic press, which gives a fairly good idea of the press used in warehouses, for bales of linen and Manchester goods, linen-yarn, &c. The ram is usually about 10 inches in diameter, and the working pressure of the water from 2 to 3 tons per square inch. As the area of the cross section of the ram is 18 square inches, this means a total pressure of upwards of 230 tons. When used for packing hay, for expressing oil from seeds, and for other purposes, alterations are made in the shape, length of standards, and, indeed, in the size of all the parts. In expressing oil, for example, there would be an alteration in the arrangement of the table or platten and the head. Sometimes the table became a piston, fitting into a cylinder attached to the head. Usually, however, the arrangement is what you see. If yarn has to be pressed, it is placed in a great oak box, bound with iron, running on wheels. It is run in between two of these columns. The pumps work, a moveable bottom of the box rises up, the pressure on the yarn gets greater and greater, and when about 230 tons is the total force, the yarn, very much diminished in bulk, is tied up, the ram descends, the great box is rolled out, and another loosely filled one is rolled behind it to undergo the same process.

For warehouse use, the pumps are often worked by hand, but even fifteen years ago I remember that orders were generally for pumps worked by power; that is, driven from shafting and worked by cranks. In this case it was common to attach a series of these presses to one set of pumps, all the presses in a warehouse being fed from a long pipe, each having its separate valve.

You will see that, although in hydraulic jacks for lifting heavy weights, the weight on the ram is the same during the whole of any operation, this is not the same in baling presses. Thus, for example, in the Indian cotton trade, governed as it is by the Suez

Canal regulations, it is necessary to press cotton so compactly that it is like a piece of oak, and it can be planed up like oak.

During the early part of the operation the pressure on the ram is therefore small, becoming very great towards the end; and it is the greatest pressure, of course, which decides the relative sizes of plunger and ram. If the ram were made to rise quickly at the beginning, and more slowly towards the end, it is obvious that there would not only be a saving of time, but a more regular doing of work.

In hand presses, it is usual to change the fulcrum of the lever, so that a labourer may work more rapidly at the beginning. It is also common to use a large pump in the early part of a pressing operation, changing it to a small one at the end; or to use two of equal size, throwing one of them out of gear towards the end of the operation.

The diagram of Wilson's hydraulic cotton-baling machine shows an earlier form than the one used at present. Instead of using one large ram, three are used. At first only the centre press is connected with the pumps, and of course it rises quickly; meanwhile the other two are filling with water from a tank, but the pressure of the water in them is insignificant. As the operation proceeds, one of the side presses is disconnected from the tank, and is now fed from the pump. The operation proceeds more slowly now, as the pump has to supply two presses instead of one; but the possible total pressure is doubled. Towards the end of the operation the third press is disconnected from the tank, and is connected with the pump; the operation proceeds more slowly still, although the pump may be working at much the same speed as in the beginning. But the possible total pressure is just three times what it would have been with only one ram.

A later form is shown in another diagram. There are twelve pump plungers attached directly to the cross heads of the steam-engines. At the beginning all twelve are working, as the pressure is small. Then as the pressure gets greater, one set of four pumps is detached, so that they do not pump water into the press, but merely pump water back to the cistern from which they draw it. Thus eight pumps are now pumping, forcing into the press less water than the twelve did before, but as they have the whole steam piston force acting on them, they are able to force the water in against a very much greater ram pressure. Later on in the operation four more pumps cease to act.

One further improvement is to be noticed. The head or platten has two long columns attached to its under side, hanging down. When the first operation is finished, the bottoms of these columns are just above the base, and may be locked firmly, so that now the head cannot fall back again. Now the finishing stroke is made, two 19″ rams are pressed downwards on the upper end of the bale with a much greater pressure than it was possible to apply with the bottom 11″ ram.

Watson's cotton press is somewhat the same. He uses fewer pumps, but he uses two bottom presses and rams, instead of one. He also uses the larger rams for pressing downwards from the top of the press to finish the operation. He is able to perform the finishing pressure operation, however, when the bottom ram is being withdrawn, so that one bale is being finished in the upper part of the press, when the box is being filled with cotton for a new bale. Here is a diagram which gives the nature of the pressures to which a cotton bale is subjected.

When the lower ram has risen 11 feet, the pressure is only 8 tons; but in another foot the pressure increases to 16 tons; in another foot, to 33 tons; and in another to 59 tons. The upper rams begin to operate when the total pressure is about 160 tons; but on moving through 3 inches, they had to exert 200 tons; three inches further, 300 tons; three inches further, 500 tons; and three inches further, that is when the ball was finished, they were exerting a pressure of 900 tons.

We see, then, that capability of working very rapidly when the pressures are small, and working very slowly when the pressures are great, on the supposition that the steam-engine is always working at the same speed—these are the important things to be looked for in hydraulic presses. It must be quite evident to all of you that there will probably be great changes in the future in these machines. Probably it is in the direction of the use of combinations of accumulators, employing Mr. Tweddell's principle, that we may look for improvements.

Miscellaneous.

FARMING IN JAPAN.

Consul Van Buren, in a report upon the laws, religion, government, &c., of Japan, has given some details respecting the condition of the agricultural classes in that country. He states that the Japanese farmer, under the old system of classes, ranked next to the "Samurai," or governing class; in the new order, he holds the same position in public opinion and general estimation. He is now owner of the soil he tills, and is taxed according to its producing capacity. The "Kocho," or village officer in all agricultural villages, has always been a leading farmer, and some villages had and still have the right to choose this officer. His duties were to settle petty disputes, maintain the peace, keep a register of the inhabitants, grant travelling permits, arrest thieves, and to be a general adviser for the whole village. Within the last two years the position and influence of the landholder has been greatly enhanced, a decree having been promulgated, by which local election assemblies have been created, the electors to which are confined to those landholders who pay at least a land tax of 40s. Farmers in Japan have no seasons of rest, as in colder climates, for the climate in nearly all parts of the country is so mild in winter as to admit of raising the hardier crops. A considerable per-centage of the landowners are not workers, large numbers of the tea, silk, rice, tobacco, and sugar producers being able to employ labourers. Almost every farmer can read, write, and keep his farm accounts. He sends his sons to school, and his daughters are taught music and needlework at home. All labour on a farm is mere hand-work, a plough being seldom seen. Sometimes, in the lowland rice-fields, an implement, five feet in length, with a wooden cross-piece, and depending iron teeth, twenty inches in length, set four or five inches apart, is used, with a horse, as a pulveriser of the soil, after the latter has been thoroughly dug up and worked over with a mattock. Ninety-nine per cent., however, of all labour is still manual. In 1878, the number of farmers, out of a population of 35,000,000, was something over 15,500,000, of which over 7,000,000 were women. The wages of an able-bodied farm-hand are about £7 per annum, with board, and £10 without board, female labour being much cheaper. To perform work in a house, or on a farm, stout healthy women are engaged at from 35s. to 40s. a year, with food, and from £5 to £6 without food. The number of hours of labour will not average more than nine, and in many cases does not exceed eight. The Japanese farmer is an easy taskmaster, and treats his farm labourers with great kindness. In ordinary farming there is little skilled labour, but in tea, silk, and sugar cultivation and preparation skill and experience are required, and paid for with higher wages. A good tea-firer on a tea plantation, or a silk winder, receives double the wages of the unskilled labourer. The food of a farm labourer is almost entirely vegetable, and consists of rice, barley or wheat, millet, beans, pease, turnips, potatoes, onions, carrots, and a few other vegetable products. In some districts rice is too high in price, and only barley, turnips, and millet are used. Religion, custom, popular prejudice, and force forbid the use of animal food. The clothing of the farm labourer in summer is little more than a thin covering for the body, in winter an addition is made of one or two cotton garments, with straw sandals or wooden clogs. The entire clothing for the year does not cost more than 16s. or 17s. Several holidays are allowed each year, such as religious festivals and family celebrations. When a man and his wife work for yearly wages they will receive, without board, about £15. From this they have to pay from 30s. to 40s. for a small-roomed house, consisting of two or three rooms, and buy clothing for a family of four or five. A small garden is generally attached to the house, from which one-half of the living is produced, and it is no uncommon sight to see a child of six or seven years, with a baby of six months strapped on its back, gathering brush or dried grass on the commons for fuel. The homes of the rice, silk, and tea farmers are the best of all the agricultural labourers in Japan. The house is often as large as thirty or forty feet square, always one storey high, with a thatched roof, strongly built, with verandah in front, and consisting of five or six rooms, one being generally kept as a spare or reception-room. On the tea plantations, ordinary labour wages are paid for the tillage of the soil, but the man who trims the plant must be a skilled labourer, and receives as much as 1s. 6d. a day. The tea picking is done by women and girls, and requires great care. When working by the day, they are paid from 5d. to 6d. Tea rollers and firers must be skilled, and can command from 7d. to 10d. a day. Silk production also gives very considerable employment to farm labourers, and as better processes of preparing silk are continually being introduced, and, consequently, a better article is produced, there is a greater demand for skilled labour, and increased wages are offered. Mulberry plantations are found in fifty of the sixty-six provinces of Japan, and the business of silk production is carried on in the house where the farmer resides. The mulberry leaves are either picked off by women and children and carried into the house, or the young branches, with the leaves on, are cut off and taken there, where the leaves are picked off, washed, cut up, and given to the worms. When the cocoons are ready for winding, that is also done by women and girls. To make an even thread requires experience, care, and skill, and such labour commands wages accordingly. Spinning, warping, dyeing, and weaving are all, more or less, skilled branches, and require skilled labour. The man who tends the trees commands ordinary farm wages, while the leaf pickers, winders, spinners, and weavers of plain cloth will get as much as 10d. to 1s. 8d. a day. Weavers of fancy-patterned goods are paid at a much higher rate, receiving as much as 4s., but this is very exceptional. On the cotton plantations the labour employed is not skilled, and is paid for at a very low rate. It was estimated, in 1875, that the total extent of land in Japan under cultivation was about 12,000,000 acres, giving to the actual farming population three-quarters of an acre per head. The tillage is of the most thorough order. Two crops are invariably raised each year, so that the producing capacity of the area cultivated is double that of the number of acres named.

THE AGRICULTURAL POPULATION IN VENETIA.

The report of Signor Morpurgo on the condition of the peasantry in the Venetian provinces, to the committee of inquiry into agrarian matters, has recently been published. This report makes many important revelations, and commences with a description of the state of the dwellings, which may justly be taken as a condition of their inhabitants. These cottages are, generally speaking, little better than huts thatched with straw, with damp earth for the floor, with the walls made of branches and unmade bricks, or ill-made lathes and plaster, containing few rooms, and more often only one in which the occupants are huddled together, without regard to age or sex.

The impression produced by this description is hightened when we consider that in the Alpine districts the houses belong to their occupants, whilst in the plains they more frequently are owned by the land proprietors, who, generally speaking, are not in a condition to make improvements, and therefore the duties of ownership cannot always be appealed to. In the Alpine districts (Friuli and Belluno), almost all the agriculturists are proprietors; not so in the hills and plains, where they belong for the most part to the class of day-labourers, divided into two categories, the day labourer proper, who works from day to day, and the permanent labourer, who is engaged by the month or the year.

The mountain agriculturist is a proprietor, who, if he did not emigrate every year, would die of hunger. The division and subdivision of property has produced an exhausting cultivation, the land yields but poor crops, sometimes not even enough to cover the very heavy taxes. The labourers belong to the agricultural class by birth only, for most of them adopt trades, which they go off to practice in Austria, Germany, and Central Italy, leaving their homesteads to the women, children, and old people. In the plains, the permanent labourers are paid sometimes in money alone, sometimes in money and kind, the latter consisting either in food and lodgings, or in a portion of the produce of the land.

Wages may vary in form, but they are everywhere insufficient, as may be seen from the following examples. In the province of Udine the pay of the day labourers of Reana del Roiale is 50 to 60 centimes, without food, but supplemented by the produce of a few yards of land, which they are allowed to cultivate; those of Pasian di Prato earn 40 centimes, with food; at Codroipo they get in winter 65 cents., and one lire in summer. In the province of Treviso, wages at Resano are 60 cents. in summer and 33 cents. in winter, with food. At Tombola, in the province of Padua, wages are only 25 cents. in winter, and 50 cents. in summer, with food; at Vicodazzere the wages are increased by one-third of the corn grown on a few yards of land. The unsatisfactory condition of the agricultural labourer is intensified by the fact that he is only paid for the actual days of work, excluding holidays and rainy days.

The day labourer proper is even worse off. In summer his rates are as high as from 2½ lire to 3 lire, but fall in winter to 50 cents. and 65 cents., and with the uncertainty of employment from day to day, often causing long periods of enforced idleness, the state of things is not satisfactory, and the most obvious results are emigration and bad sanitary conditions Emigration is either temporary or permanent. The former is an old custom in the greater part of Venetia, the emigrants coming from Friuli and Belluno. The peasants go to other countries because the land will not support their families, and there being no work to do at home, they leave for a few months, returning to their homes for a few weeks, and then start off again; they do a little of everything, bricklaying, woodcutting, masonry, knife-grinding, and cutlery, being the principal occupations. This emigration helps to diminish the disproportion between the number of mouths at home, and the food to feed them.

Emigration across the sea is, numerically, of but small importance. It was at its height in 1876 and 1877, but is now decreasing. Its ranks were filled chiefly from the small landowners, for those who have not a few acres to sell could scarcely scrape together enough money for the journey. The writer of this report gives no figures in reference to either kind of emigration, but says that the official figures are far below the truth.

With regard to the food question, the facts found in the report are far from encouraging. Polenta at morn, polenta at noon, polenta at night, was the invariable answer made to the questions of the reporter in every part of Venetia. Luxuries or change of diet, with the exception of occasional vegetables, and now and then a little salt fish or bacon, were absolutely unknown. Wine, as a rule, is drunk only at harvest time; during the rest of the year water is the only beverage, and even that, in the valleys, is often bad.

The sanitary condition of the inhabitants is as bad as possible. The results of unhealthy dwellings and unwholesome food require no investigation; 8 per cent. of the conscripts of these provinces are rejected on account of constitutional weakness, a per-centage which is reached in no other province except Lombardy and Sardinia. Venetia, too, is among the chief sufferers from the *pillagra*, which is rapidly increasing. In fact, the whole report may be summed up in a single sentence; poverty and grinding starvation are wearing away this stout Venetian race. Turning to the moral side of the question, the report is more satisfactory. The population, as a rule, are gentle and obedient to law. The only crimes at all prevalent are pilferings of the standing crop, prompted and partly excused by hunger. Even in this respect, however, the tendency is towards a change for the worse.

THE COTTON MANUFACTURES OF CHINA.

That the Chinese were acquainted with the properties of cotton before they began to cultivate it for themselves, is proved by passages in various historical works. In the "Book of Historical Documents," reference is made to the cultivation of cotton during the dynasties of Sung and Yuen (A.D. 1127–1333). The provinces of Kwang-Tung and Fo-Kien were the principal homes of the industry at the time of its establishment, which is fixed, by the annals of the empire, as having taken place during the Yuen dynasty. This assertion would give the event a date anterior to A.D. 1333. The statements of different writers as to the districts in which the plant was at the first successfully cultivated, do not, in all cases, coincide, but the date of its introduction seems generally agreed upon as being about the commencement of the 14th century of our era.

Some interesting details as to the present mode of cultivation are afforded by the *Central-Blatt für Textil Industrie.* The plant is usually grown in fields where wheat and barley have previously been cultivated. Sowing takes place in June, and the plant soon makes its appearance, but seldom attains a height of more than a foot and a half. The leaves are dark green, and the blossoms (which appear in August) are yellow. Women and children gather in the crop in baskets. The cotton is subsequently passed through two wooden rollers.

Before being spun, it is spread out on the ground, and is cleaned by means of an instrument specially adapted for that purpose. It is spun into yarn by means of a primitive spinning-wheel, such as is found in most cottages in China. The looms are served by men and women; in those districts considered as centres of the industry, a large proportion of the population are employed in cotton-weaving.

The material known as Nankin (so designated after the city where it was first manufactured) is a favourite and durable product of Chinese looms. The extent of the cotton industry has notably increased in Hankow, an important city in the province of Hoo-Pah. It must not be forgotten that the ordinary Chinese wears cotton all the year round. A complete suit costs about five shillings, and lasts for six months. In winter, these cotton suits are wadded, or several suits are worn, one above another. The lining is a description of coarse towelling drill, which is woven by the Chinese so as to resemble a kind of white fur.

Cotton velvet is an important feature of the Chinese textile industry. It is a soft and durable material, and is usually made of a dark blue colour; it is dyed in a solution of one part indigo, to thirteen of water, with a small admixture of wine and lime. The velvet lies for half-an-hour in this solution; it is then wrung out and dried in the sun. The tissue is subjected to this process no less than eleven times. It is subsequently damped by a workman, with slightly acid water, which is let fall on the material in the form of a fine rain.

The calendering is done in a somewhat primitive fashion, but is successful in giving considerable brightness of appearance to the material. Prussian blue is sometimes used instead of indigo. This article was at one time imported, but the Chinese now make it themselves, the details of its manufacture having been learned by a Chinese sailor, when in England. It now constitutes an important feature of Chinese industry.

The seeds, which are not used for sowing purposes, are employed in the production of oil, and have also a certain amount of medicinal repute amongst the Chinese.

Notes on Books.

THE METAL TURNER'S HAND-BOOK.—By Paul N. Hasluck. London: Crosby Lockwood & Co. 1882.

This little work contains descriptions of the various forms of amateur lathes and appliances connected with them, made by many of the manufacturers of this country. Prices are given, and other information likely to be useful to an intending purchaser. There is also a good deal of information as to the construction and use of tools, guiding, and other matters connected with the lathe. A chapter is devoted to motors for the lathe, in which the principal small motive-power engines seem to be included. It should be mentioned that the book, which contains over 150 pages, and very fully illustrated, is issued (in a cloth binding) at the cost of a shilling.

THE OPEN FIREPLACE IN ALL AGES. By J. Pickering Putnam, architect. New edition, revised and enlarged. Boston (U.S.). 1882. London: Trübner and Co.

The author, in the first chapter, deals with the fireplace as it is; and in the third chapter, he makes suggestions for its improvement. The second chapter is devoted to the history of the subject. In this, the transformation which the fireplace has undergone, from the smoke-flue in the primeval hut, to the modern hearth, is fully set forth. The largest portion of the work is devoted to suggestions for improvement, in which a variety of schemes are discussed, and the principles to be borne in mind in all proper systems of heating are set forth. The external appearance, as exhibited in the chimney tops, also is not forgotten. Besides numerous illustrations of practical forms, used and suggested, there is a selection of historical examples from famous mansions in France and elsewhere.

FAMILIAR LESSONS ON FOOD AND NUTRITION, INTENDED TO SERVE AS A HANDBOOK TO THE FOOD DEPARTMENT OF THE PARKES MUSEUM OF HYGIENE. By Thomas Twining. Part I. London: David Bogue. 1882.

This first part of a proposed handbook to the contents of the Parkes Museum, deals chiefly with the principles of food, and is intended also to serve as one of the sequels to Mr. Twining's course of elementary lectures, entitled, "Science Made Easy." The second part will be devoted to a description of the contents of the several stands in the museum. The reader is led on from a simple explanation of the constituents of food, and of the objects served by their proper arrangement and use in the animal economy, to the consideration of the preservation of food and of various culinary processes. The appendixes consist of tables, showing the constituents of the human body, and a synopsis of the most important modern classifications of food.

SPONS' ENCYCLOPÆDIA OF THE INDUSTRIAL ARTS, MANUFACTURES, AND COMMERCIAL PRODUCTS. Division V. Edited by Charles G. Warnford Lock, F.L.S. London: E. and T. N. Spon. 1882.

This volume completes the important work which Messrs. Spon have been producing during the last few years. It contains the continuation of the article on photography, and among the chief articles included in the present division may be mentioned pottery, printing and engraving, resinous and gummy substances, silk, soap, sugar, tannin, tea, and woollen manufactures. These headings will give an idea of the range of subjects dealt with in this Encyclopædia, There are, first, the raw commercial products, which have been, in most instances, arranged in groups, according to their similarity of origin, character, and application; then come the articles of manufactures and industries, which are connected, on the one side, with chemistry, and, on the other, with mechanics. In the last class, textile articles play the most important part. The assistance of specialists has been obtained in the compilation of the several articles, and the whole work has been edited by Mr. Lock. To most of the articles a short bibliography of the subject is added, and a full index to the 2,112 pages of the work, concludes the present division. The need of a full index will be the more apparent, when it is noticed that many of the headings contain a multiplicity of subheadings; thus the article resinous and gummy substances deals with amber, copal, frankincense, gutta-percha, india-rubber, lac, tars, turpentine, and many other similar substances.

WORKED EXAMINATION QUESTIONS IN PLANE GEOMETRICAL DRAWING. By F. Edward Hulme, F.L.S., F.S.A. London: Longmans, Green and Co. 1882.

There are here 300 questions to be worked by the student, and 61 sheets of illustrations, containing solutions of 200 of the questions, for reference after the answers have been prepared. As problems may often be worked in more than one way, the author has, in certain cases, shown in his illustrations the different methods that may be adopted. The work is chiefly intended for the use of candidates for the Royal Military Academy at Woolwich, the College at Sandhurst, the Engineering College at Cooper's-hill, the Oxford and Cambridge Local Examinations, &c.

ART INSTRUCTION IN ENGLAND. By F. Edward Hulme, F.L.S., F.S.A. London: Longmans, Green and Co. 1882.

Mr. Hulme has given in these pages an account of the various organisations in England for the purpose of teaching art, chiefly in the direction of drawing. This object has been to illustrate the value of art teaching, and to trace it from the lowest grade school to its highest developments under the instruction of specialists at the Universities. He points out what subjects are taught, and how and why they are taught at the various institutions throughout the country.

General Notes.

INDIAN FELT.—The *Moniteur des fils et tissus* refers to a kind of felt thus designated, obtained by M. Villedieu from the waste arising from the wild cocoons gathered in the forests of China, Japan, and Australia, which are used in reeling Tussah silk. The value of this waste is from 7d. to 14d. per pound. The thickness of the felt thus produced is one-half that of hair felt, and it is remarked that this substance is equally applicable to the manufacture of hats, and to furnishing purposes. After being carded and dyed, the filaments (whether finished or not) preserve the brightness which is characteristic of silk. The substance in question can be used either pure, or mixed with a small proportion of hair, wool, cotton, &c.

PRODUCTION OF LEAD IN 1881.—Herr Landsberg, the general manager of the Stolberg Company, has, in an annual report to his company, given an estimate of the production of lead in Europe, for 1881, which is as follows:—Spain, 120,000 metric tons; Germany, 90,000; England, 67,000; France, 15,000; Italy, 10,000; Greece, 9,600; Belgium, 8,000; Austria, 6,000; Russia, 1,500; total, 326,500. Herr Landsberg estimates the production of the United States at 110,000 tons. As the output of Mexico, South America, Canada, and Australia, is small, it may be assumed that the world's production is about 440,000 tons of lead. This does not include China, which is a heavy consumer of lead, and is not unlikely a producer of some importance; nor does it include Japan, of whose output there are no figures.

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Proceedings of the Society.

CANTOR LECTURES.

HYDRAULIC MACHINERY.

By Professor Perry.

*Lecture II.—Delivered March 13th, 1882.**

In taking up the subject of hydraulic press-work in my first lecture, I tried to give you exact notions on the subject of pressure in fluids not in motion. We supposed, and shall suppose for a short time, that the weight of the fluid itself was insignificant, and we found that the pressure on each square inch of surface touched by the water, and on each square inch of interface separating two portions of the fluid, was everywhere the same.

One of the best methods of observing the pressure, anywhere, is by inserting a pressure gauge, such as the one you see before you. The gauge indicates the pressure per square inch at the part of the liquid to which a communicating little gauge tube penetrates. It always does so when there is no motion of the fluid at the point in question; but, unfortunately, when there is motion there, the introduction of the tube alters the motion there, and, more or less, falsifies our measurement.

Pumps.

A pump is a machine which gives energy to water; that is, it can raise water to a height, giving it potential energy. It can force water into a vessel under great pressure; that is, it can give water pressure energy. It can set water in motion; that is, give it kinetic energy.

1. A pump must be efficient; that is, it must do nearly as much work on water as the pump itself receives from an engine or labourers. But it must be remembered that the best pumps used for different purposes have very different efficiencies. Forty per cent. would be regarded as a reasonable efficiency for reciprocating-pumps of low lift, whereas it would be regarded as rather poor for pumps of high lift.

2. Pumps must not be liable to get out of order, and they ought to be readily examined, as their caretaking is usually entrusted to unskilled persons.

Pumps are either reciprocating, rotary, or centrifugal.

Reciprocating-pumps are either lift-pumps, or force-pumps, or combinations of both.

[Here sectional models of a common country-house lift-pump and piston, and plunger-piston force pumps, were worked and described.]

The peculiarity of these reciprocating-pumps is that, when there is no slip, there is the same quantity of water passed through the pump at every stroke. If we know the size of everything, then the speed of the pump tells how much water is delivered, and if we know the height to which it is delivered, we know the work done.

Now, in a centrifugal-pump everything is somewhat different; with a given speed of pump, we may have very different quantities of water passing. The work which has to be done does not merely depend on the speed of the pump, then; it depends on the speed and the quantity of water. We may have the pump running at a certain speed, and no water being delivered, and very little work being done, only frictional work in fact. Now a slight increase of speed may cause an abundant flow of water, and a tremendous increase in the work being done. Strange to say, if this speed be now diminished to what it was at first, it does not follow that the water will cease to flow.

We have here before us a number of small and large specimens of centrifugal pumps. In all of them you observe that there is a central wheel, with vanes, which can be rotated very rapidly. Water can enter the wheel on both sides at its centre from these two supply pipes, which meet in one pipe below. The water filling the space between the vanes and being whirled round with great velocity, tries to get away at the circumference of the wheel, because of the centrifugal force, and it flows out into this casing, which gradually becomes the discharge-pipe of the pump. So much you were all already aware of, but we must now consider the flow of the water more carefully.

What occurred when the pressure in the pump of the hydraulic press became greater than the pressure of fluid in the press?—There occurred a flow of fluid. The fluid was set in motion from pump to press. Remember, then, that a difference of pressure between two places which communicate with one another, means a tendency to produce motion.

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* The blocks of Figs. 2, 3, 7, 9, 10, and 18, in Lecture I., were kindly lent by Messrs. Cassell, Petter and Galpin, and those of Figs. 11, 12, 13, by Messrs. Tangye Brothers.

In the hydraulic press the flow is intermittent. Why? Because the pressure is intermittent. You may be sure that when you have a certain difference of pressure between two places, and this is always the same, the flow of fluid is perfectly steady; and we saw in our last lecture that work is then done on the fluid with perfect uniformity. We also saw how to tell what work was done. The work done on a fluid in a minute is simply the difference of pressure per square foot which causes the flow, multiplied into the number of cubic feet of water which flow per minute. This gives the answer in foot-pounds.

I am coming now to something which it has rather puzzled everybody to explain in any simple fashion—a puzzle to all hydraulic engineers—and, as I think it explainable, you will please try to follow my lead with some care.

Suppose that with pumps, or in any other way, I establish a difference of pressure between a place A and a place B, and suppose I know that my pumps and other arrangements will not break down—in fact, that the difference of pressure between A and B is really a fixed thing on which I can depend—you know perfectly well that the flow of water from A to B will be perfectly the same at all times, and that the same amount of work will be done upon it every minute. If, now, we leave out of our minds all consideration of how that constant difference of pressure has been produced—merely think of the two vessels A and B—you are perfectly certain that this difference of pressure which has been established is really a store of energy. What enables us to call it a store of energy? The fact that we know it will not be suddenly destroyed.

Suppose you know that a man has a certain income paid, say, by Government, and suppose you are perfectly certain that this income is constant, you can regard the certainty of the man's income as a store. To say that a man gets a sovereign a-day is not of much importance, but to say that the man has a regular income of one pound a-day makes him a respectable member of society, and a store of social energy.

A man may be sitting in Parliament, but this in itself does not make him a store of political energy; but if you know that he is certain to sit there for a length of time—that a general election or general vote of the House is unlikely to unseat him—you can regard him as possessing a store of political energy.

Similarly, a pound of water in the vessel, A, at rest, possesses more energy than a pound of water in the vessel, B, at rest. How much more energy has it? If the difference of pressure is p lbs. per square inch, then it has $2{\cdot}3\,p$ foot-pounds of energy; not in virtue of its own intrinsic worth, but because it is where it is, and because we know that if it flows into the vessel B, nothing will alter in the pressure conditions of the two vessels till it gets into the vessel, B. You understand, then, that a pound of water, subjected to a pressure of p lbs. per square inch, may be said to have a store of $2{\cdot}3\,p$ foot-pounds of energy, if we know that the motion which is occurring in the water is steady, and is not altering capriciously.

Thus a pound of water at the pressure of the atmosphere, 14·73 pounds per square inch, possesses, in virtue of this pressure, $2{\cdot}3 \times 14{\cdot}73$ or 34 foot-pounds of energy. It would possess the same energy if it were at the pressure 0, the pressure in a vacuum, but were 34 feet higher than it is in position.

Suppose that A is a closed box, and that it is filled with water, under great pressure. Now, suppose I open a valve, and let this water escape. Although there was a tremendous pressure, p, just for an instant, and, therefore, a rapid flow of water just for an instant, this almost instantly dies away, because the pressure in A is almost instantly diminished. Every pound of the water did not then have a store of $2{\cdot}3\,p$ foot-pounds of energy, and yet it was at the pressure of p pounds per square inch. It is the certainty that the state of pressure in A will continue constant that gives to pressure its significance, and gives to us the liberty of regarding pressure as a store of energy.

It now becomes necessary for us no longer to neglect the weight of the fluid itself.

Suppose that we have, anywhere, steady motion of water. Consider a pound of the water. What is its total store of energy?

1. It is h feet above some datum level. Then if one pound of water ever were allowed to fall to the datum level, it would do h foot-pounds of work in falling. Remember that the mechanical energy stored up in a miller's dam is simply the weight of the water, multiplied by the height of the water through which it can fall. Of course, if any other volumetric force acts on the pound of water, this will con-

stitute another store of potential energy. I am supposing that the weight of the water is the only volumetric force.

2. As the motion is steady, if the water is at a place where pressure is p pounds per square inch, it possesses, in virtue of the fact that the motion is of a steady character, the store, 2·3 p foot-pounds of energy.

3. As the water is in motion, if v is its velocity in feet, per second; as its mass is $1 \div 32{\cdot}2$, we know that its kinetic energy, or energy of motion, is 1-64th of the square of the velocity.

The following table shows the relative values of h and p and v, if we wish to convert one of these forms of energy into another. Thus the energy due to a difference of level of 2·3 feet is equivalent to that due to a difference of pressure of 1 lb. per square inch, or to that due to a velocity of 12·18 feet per second.

Difference of Level.	Pressure.	Velocity.
2·3 feet.	1 lb. per sq. in.	12·18 ft. per sec.
16·1 ,,	7 ,, ,,	32·2 ,, ,,
34 ,,	14·73 ,, ,,	45·7 ,, ,,
64·4 ,,	28 ,, ,,	64·4 ,, ,,

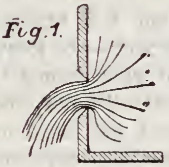
Now, I shall not suppose that the pound of water has any other stores of energy than these. Remember that, as it is compressible to some extent, it may have a store as the mainspring of a clock has. This store must always be taken into account when the fluid is air or any other gas. It may also be electrified or at a high temperature, or it may have other stores of energy which I am neglecting. Merely think of these three stores. Potential energy due to height above a datum level. Pressure energy due to the unchangeableness of things. Kinetic energy due to its actual motion.

Now, what I want you to remember carefully is the fact that this pound of water retains all of this energy except what it loses in friction. Suppose that a man has capital in the shape of gold, capital in the shape of shares which never alter in price, and capital in the shape of a pet manufactory, which wastes money just in proportion to the amount of capital invested in it. He may buy more shares or sell them out, invest more or less money in the pet manufactory, but all the time his only loss is the loss from the manufactory. He may have no gold, or no shares, or very little money in the factory, but all the time his total capital is unchanging, except that he loses in proportion to the value of his factory. It is only when water has part of its energy in the shape of kinetic energy, only when it is in motion, that it loses any part of its total store.

Consider a lake of water at rest. Consider a point A, and somewhat below its level another point B. A pound of water at A has the same store of energy as if it were at B. In neither case is there any energy of motion. The store of energy at A is merely due to height above some datum and the pressure per square inch at A. Now, if a pound of water gets to A from B, it loses potential energy h foot-pounds, if the difference of the level is h feet, and it ought to gain an equivalent of pressure energy, and the gain of pressure is, as we have already seen, simply $\frac{h}{2{\cdot}3}$ pounds per square inch. Thus, if h is 34 feet and p is the gain of pressure, then there is a gain of pressure energy of 34 foot-pounds, that is, there is a pressure at B of $34 \div 2{\cdot}3$, or 14·73 lbs. per square inch greater than the pressure at A. This is an increase of pressure called one atmosphere. In still water there is an increase of pressure of one atmosphere for every 34 feet of descent.

To further familiarise you with the idea, let us consider the flow of water from an orifice.

Fig. 1.



In Fig. 1 you will see the stream lines along which water flows out of the orifice. The shapes of these stream lines will depend on the shape and position of the orifice.

Now, a pound of water at A is at atmospheric pressure, and when it reaches B it is also at atmospheric pressure, so that its pressure energy remains the same.

But at A it has fallen h feet; it has lost h foot-pounds of potential energy, and it must therefore have gained h foot-pounds of kinetic energy. If v is its velocity, then $v^2 \div 64$ must be equal to h, so that v may be calculated; hence its velocity is just the same as that of a stone which had fallen freely from A to B.

[To illustrate this a high vessel was shown, from which at different levels tubes came out, ending in nozzles, throwing jets vertically upwards.]

These jets do not rise to the same height, because there is a loss of energy due to friction, and this friction occurs principally at the nozzles. If the jet reaches within a distance h_1 of the level of still water inside, and if the nozzle is the depth h below still water level, then if we may say that all the friction occurs at the nozzles, $h_1 \div h$ expresses the fractional loss as a fraction of the whole kinetic energy at the nozzle.

[This calculation was made for different levels of the water in the vessel, and gave nearly the same result in every case, showing that the frictional loss of energy seemed to be proportional to the kinetic energy there.]

There is very little friction in the case we are considering—and we have a very simple statement of the velocity at B.

Can we say the same about the velocity at C? Certainly not. If we knew the pressure energy at C, we could say how much of the lost potential energy has been invested in this shape, and, therefore, how much has been invested in the shape of kinetic energy; but without knowing the pressure at C, we cannot tell what is the velocity there.

In this subject of flowing water there are more misleading hypotheses, due to perverted ingenuity, than in almost any other, and, unfortunately, the logical conclusions drawn from these hypotheses, when known to be untrue, are said to be the statements of *theory* as opposed to *practice*. You often hear the statement; the theoretical velocity at an orifice is the velocity which the water would have acquired if it had fallen freely, as in a vacuum, from still water level, whereas it is evident that we cannot tell the velocity at any point in the jet, unless we know the pressure there, and we only know the pressure on the very outside of the jet.

Now, although we do not know the pressure or velocity at every point of water flowing from an orifice, the studies of Professor James Thomson enable us to make certain important statements which agree with experiment. One of these is this:—

When frictionless liquid flows from two similar vessels through similar orifices similarly situated with regard to free water level, the lines of flow are exactly of similar shape; the velocities at similar points are exactly as the square roots of the dimensions of the vessels, and the total quantities of liquid which flow are proportional to the square roots of the fifth powers of the dimensions.

Thus, if we have water flowing similarly om three similar vessels, all made from the same drawings, but to different scales—say one 1 foot, another 4 feet, and another 9 feet deep—the velocities at similar points are as 1 to 2 to 3, and the quantities of liquid flowing from the three vessels are as 1 : 32 : 243; thus we are quite sure that 243 times as much liquid flows from the third vessel as from the first.

Hence, suppose I want to know how much water is flowing in a small stream, I dam the water up somewhere, and let it flow out of my dam through a notch like this (Fig. 2), (a right-angled isosceles notch) in a wooden board with sharp edges. Indeed, I prefer to have the edges of the notch made of metal, so that I shall be sure they are straight and sharp. Measure the height of the still water in the dam above the lowest point of the notch (D). This one measurement tells me how much water is tumbling over. For I know that, suppose there is rather a drought one day, and *a* shows the appearance of the notch; and on another, a rainy day, A shows its appearance, you will observe that the orifices through which the water is flowing are similar, and similarly situated with regard to the still water level; and Thomson's theory enables me to say, that if on one day the height is 1 foot, and on another it is 4 feet, then 32 times as much water comes over on the second day as on the first. The flow of water is exactly proportional to the square root of the fifth power of the height D A.

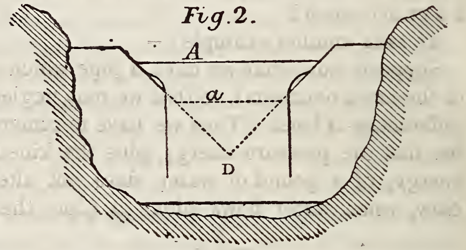


Fig. 2.

Now, Thomson measured very accurately how much water is flowing when the height is 1 foot, and he found it to be 2·54 cubic feet per second. Hence we have the rule; measure the height D A, at any instant, in feet; raise this to the fifth power, and extract the square root, and multiply by 2·54, and you know how much water is flowing in cubic feet per second.

If we know the cubic feet of water flowing per second, we know the weight of the water, since a cubic feet of water weighs 62·3 lb., and the weight of water, multiplied by the number of feet through which we can let it fall, tells us the foot-pounds per second—the available power of the stream. The foot-pounds per minute, divided by 33,000, is, as you all know, the horse-power of the stream.

Gauge notch observations, made from day

to day on a stream, enable a person to make very exact calculations as to the power available for the driving of mills by turbines, for the working of hoists, cranes, and lifts, and for hundreds of other purposes.

I wish I had time to tell you how Thomson employed that same theory of his in proving that the famous Lowell empirical formula, for rectangular gauge notches, was really a rational one. I must finish here my talk about gauge notches; but if I have incited any of you to criticise the absurd statements in nearly all the books, and to go for exact ideas to Thomson's paper in the Proceedings of the British Association, I have done you a most important service.

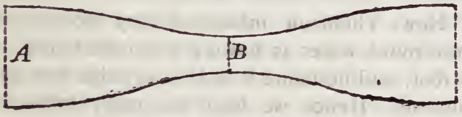
You see now what a lot of important and rather abstruse looking questions are easily explainable, when we fully grasp the significance of that energy law.

The fundamental fact which makes any hydraulic problem clear to you is this. If we may neglect friction, then a pound of water at any place has its total energy in three shapes. It has h foot-pounds of energy, because it is h feet above a datum level. It has $2{\cdot}3\,p$ foot-pounds of energy, because its pressure is p pounds per square inch, and it has $v^2 \div 64{\cdot}4$ foot-pounds of energy, because its velocity is v feet per second.

To take another example :—

Suppose, now, that we have a pipe which is in the main horizontal, so that we may neglect differences of level. Then we have to remember that the pressure energy, plus the kinetic energy, of a pound of water, does not alter. Now, when water flows along a pipe, there must be the same quantity flowing everywhere. We are sure, therefore, that there must be greater velocity wherever the pipe is contracted. But greater velocity means greater kinetic energy, and if this water invests more of its energy kinetically, it must have less in the shape of pressure energy. That is, the pressure of the water at B (Fig. 3,) is less than at A or at C. The pressure at B may become very small indeed. It is easy, in this way, to reduce the pressure to much less than the atmospheric pressure—merely contracting the cross section of the pipe is sufficient. You cannot make the pressure less than that of a vacuum, for before that limit is reached, we get vapour formed.

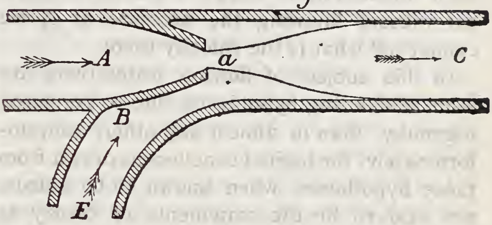
Fig. 3.



Now, suppose a conduit of this kind were carried over my fields, and that a quantity of water lay in my fields, at not too great a depth below the conduit. If I bring a pipe from the point B, underneath the field-water, this becomes a suction-pipe, and I get my fields drained at the expense of the conduit owners. I spoil their water, if it is clean, but at all events I get my fields drained.

In this lies the whole theory of jet pumps, and injectors, &c. The jet pump of Professor James Thomson simply consists of a small pipe, A (Fig. 4), which ends in a nozzle. Through this, let me suppose, I have a small supply of water flowing from some pretty high cistern or other reservoir. Suppose that this water flows into the atmosphere at C. Evidently the pressure at a is much less than the pressure at C. It is less than the atmospheric pressure, and hence the neighbourhood of a is a partially vacuous space, so that the pipe, B, E, becomes a suction pipe, and water tends to flow from a point at E, to B, and on to C. Thus, if we have a small supply of water from a high cistern, we are able to drain a marsh with it.

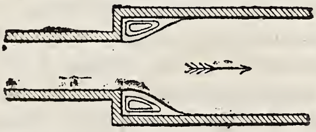
Fig. 4



I have not time to tell you of the hundred other ways in which our simple principle comes in to simplify all sorts of puzzling phenomena, but I may be pardoned in referring to my brother's syphon, for the discharge of flood-waters at the weirs in rivers. It has no moving parts in the water, being simply a wide, open pipe of varying sectional area, through which an object as large as a bullock might pass, without injury to the sluice. It has been found, by actual trial, that the quantity of water passing per minute through such a sluice is independent of the fall, so long as there is sufficient fall to balance the waste by friction in the pipe, a few inches being enough in the case of wide pipes; and a velocity of 45 feet per second, at the smallest section, may be calculated upon when the sluice is working full power. The cross-section of the syphon is like the letter D at the tail; the masonry, or concrete basin, is actually a portion of the syphon, and the horse-shoe shaped space between the lip of the basin and the iron edge of the syphon proper is the actual opening. The quantity of water passing at any time is regulated by the admission of air to, or its exclusion from the syphon. There is a throttle-valve arrangement by means of which the syphon may be adjusted at any time, so as to vary what may be called the normal water level in the reach above the sluice, and to vary the opening through which a constant stream of water falls on a ridge-shaped portion of the syphon. This stream of water is needed to exhaust the syphon of air, so that action may be set up at any time, even when the water is not passing over the top of the throttle valve. The manipulation of such sluices is perfectly simple, they may be made self-acting; but it is proposed in important places to work all the sluices on a river from a single station electrically.

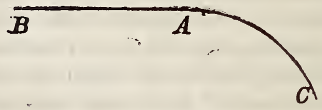
I told you that friction, loss of energy by friction, in water, is proportional to the square of the velocity at such speeds as are common in pumps. I shall not trouble you with the exact rule by which we are able to calculate the loss of energy which a pound of water experiences in going along pipes, But I want to impress on you the fact that this loss always becomes very great and abnormal when the flow of the water has to occur abnormally. In this pipe (Fig. 5) you see that the wide and narrow parts gradually change into one another by continuous curves. Remember that it is absolutely impossible for a liquid to flow in a discontinuous curve. Suppose you try then to make it flow along the pipe (shown in Fig. 5). What the water does is this: when it comes to the corner it produces for itself wheels, little eddies or whirlpools, as we would put rollers under a log of wood that we wanted to get along easily, and there is great loss of energy due to this, for the eddies have not only to be in the corners, but there are smaller eddies carried along by the water itself, maintained so long as they are needed.

Fig. 5.



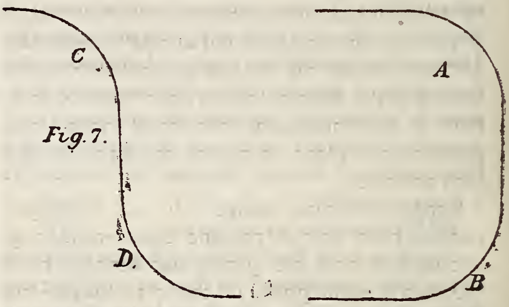
I have been speaking of actual discontinuity in the flow. But there is a fact, which I am sorry to say that ordinary hydraulic engineers seem to be quite ignorant of, namely, that a liquid cannot flow along a path which suddenly changes in curvature. A liquid cannot, for example, flow along this path (Fig. 6).

Fig. 6.



At A it changes from a straight line, suddenly to the arc of a circle, and, consequently, the water digresses at A, and creates little castors, little eddies to carry it by a path of continuous change of curvature from B to C. Now this view of mine can be shown to be true experimentally. Thus it has been found that if water flows along this bend (Fig. 7) it loses a certain amount of energy on account of the bend; but if you make the pipe bend as much again in the same direction you do not get again the same loss; indeed, there is comparatively very little loss at the second bend. But if you bent the pipe in the opposite direction, there is as much loss at the second bend as at the first.

Fig. 7.



The little wheels, or castors, or eddies which the fluid creates for itself to carry it through the bend A are available when the water needs them again at B, whereas the wheels or eddies produced at C have to be destroyed, and new ones created, rotating just in the opposite direction to carry the fluid through the bend C.

You see now how necessary it is that all curved vanes or other surfaces along which water flows should be drawn, not with a pair of compasses, but rather with a batten, a thin strip of wood, which can bend gradually.

Now I want you to regard a pump as a contrivance, which gives to every pound of water passing through it an additional store of energy. From the pond to the entrance to the pump, every pound of water has just the energy it has in the pond, barring frictional loss. From pump to cistern, every pound of water has an additional store of energy, and it is the pump which gives it this store.

Suppose we have a centrifugal pump going at a regular speed, and discharging a regular quantity of water. In this supply-pipe a pound of water has a certain total amount of energy which we know, if we know its height above datum, its pressure, and its velocity. But, in passing through the wheel, it receives a supply of energy. The total energy of a pound of water in the discharge-pipe is greater than what it is in the supply-pipe. We can make all sorts of calculations, if we know what is the clear gain, the clear gift of energy it gets in passing through the pump.

The calculation of the work which the vanes of any wheel, whether centrifugal pump, water wheel, or turbine, give to water in passing through it, has been made so difficult by ingenious students, that I am afraid many of you, recollecting your old struggles with the difficulty, think me foolish to endeavour in a short popular lecture to give exact ideas to you. Now, I have not much time, but I think I can promise you clear ideas, if you promise me your attention.

Suppose a man jumps into an American railway train anywhere, and after wandering about, fore and aft, jumps out again. Find the man's momentum in the direction of the train's motion just before he alights on the train. Find his momentum in the same direction when he has just sprung from train; the difference of these is the total impulse with which he acts on the train. It is the momentum which he gives to the train. Suppose that a number of people could perform this acrobatic feat every second with the greatest regularity, then the momentum given in one second to the train could be calculated. But momentum given per second is what we call force; hence we have found the force acting on the train due to these jumping individuals, and this force multiplied into the space passed through by the train in one second, gives the propelling work done upon the train per second. I have nothing to do with whether it is a propelling force, or a retarding force. In the one case, the acrobats do work on the train; in the other, the train does work upon them. That is quite clear; the loss of momentum per second in a regular stream of people, going on and off the train, is a force which is applied to the train. We only have to do with their momentum in the direction of the train's motion.

Now suppose that, instead of its being a train, it were a sort of circular turntable, or a merry-go-round, and that a regular stream of people jumped on and off. In this case, the place where a man jumps on may be going at a different speed from the place where a man jumps off; but our rule is not very different. Find how much is added per second to the momentum of the wheel at the point where people leap on, and regard this as a force. Multiply by the speed of the wheel there, and this is the work done by the mere leaping on, and staying on the wheel. Now, find how much per second is taken from the momentum of the wheel at the place where leaping off occurs, and regard this as a force opposing the motion. Multiplied into speed at the leaping-off place, we have the work taken by the stream of people from the wheel, per second, because they leap off. The difference in these two things is of course the work done in the jumping on and off.

Now the water moves towards the vanes of this centrifugal pump, merely radially, and hence the water entering the vane cannot add to or diminish the momentum of the wheel just there. It has no momentum of its own, previously, in this direction. What occurs inside the wheel now, we have nothing to do with, excepting that we know frictional loss occurs there. We are only concerned with how the water leaves the wheel. The way in which it is made to leave the wheel determines how much energy it gets from the wheel.

Take the simplest case. Suppose the vanes to be radial at B (Fig. 8). That is, besid moving outwards radially at B, the water leaves the vane with the same tangential velocity as the vane at B has. Suppose this velocity to be v. Then every pound of water leaving B per second, leaves with a tangential

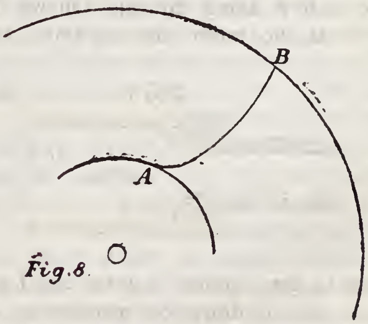


Fig. 8.

momentum, $v \div 32{\cdot}2$, and retards the wheel with a force of this amount acting at B. This force $\times\ v$ is the energy which it receives per second from wheel or $v^2 \div 32{\cdot}2$. One pound of water, therefore, receives the energy $v^2 \div 32{\cdot}2$ from the wheel in passing through it.

You understand, then, that a pound of water in the discharge-pipe of that centrifugal pump has this greater store of energy than a pound of water in the supply-pipe, except for frictional losses. If we make the water go out from the wheel as these vanes make it go, and as it would be dangerous for you to do from a railway train, less work has been done upon it by the wheel. If it goes out in the direction of motion relatively to the wheel, more work is done upon it than I am now supposing.

You understand, then, that the wheel gives $v^2 \div 32{\cdot}2$ foot-pounds of energy to one pound of water. If you know how many pounds of water pass through the wheel, you know, then, the total amount of work done by the wheel.

Remember that the water gets this energy to squander or store as it pleases, and it does squander it in friction to a large extent. But suppose it squandered none of it, but converted it all into potential energy in lifting itself up to a cistern, it would lift itself $v^2 \div 32{\cdot}2$ feet high; that is, it would lift itself above the pond to twice the height due to the velocity of the rim of the wheel. Suppose the rim of the wheel has a velocity of 45·7 feet per second, a stone would have to fall freely 34 feet to acquire this velocity, and hence the total rise of water would be 68 feet, twice the height due to the velocity of the rim of the wheel. In this case we should say that the pump was perfect.

Remember, however, that the wheel itself receives energy from the engine through this shaft, else it could not give energy to the water. It gives out all the energy that leaves the engine, except what is wasted in bearings everywhere, and what is wasted at its own friction with the water.

You understand, then, the energy given out by the engine per pound of water, divided into $v^2 \div 32{\cdot}2$, is the efficiency of the shafting, belting, and wheel.

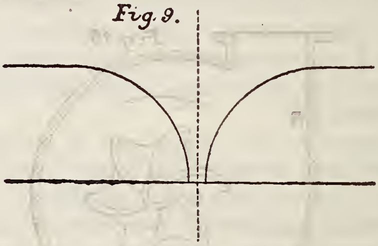
The real height to which water is lifted by the pump, divided by the ideal height, $v^2 \div 32{\cdot}2$, is the efficiency of the water passages all through the pump.

The loss in these places is due to friction. Make the supply-pipe wide, make it bell-mouthed at the bottom, where water enters it, so that it may enter by gradual curves; make the approach to the wheel at B as gradual as possible; let the vanes of the wheel make the calculable angle with the central circle, which will reduce the shock there; make the discharge-pipe wide, and let the velocity with which the water enters the upper cistern be as small as possible, and you will greatly reduce the waste of energy. But there is one particular place where there is usually much greater waste than anywhere else, and that is the discharge chamber.

Just when the water leaves the wheel, a large portion of its energy is kinetic. It is in rapid motion. Now in the large discharge-pipe there may be as little kinetic energy as we please. Hence, from the time the water leaves the wheel, till it enters the discharge-pipe, there ought to be great care taken in allowing the kinetic energy to become converted into pressure energy.

Professor James Thomson discovered here the efficiency of a whirlpool chamber. When you let water escape from a wash-basin, you know that the surface of the water takes a shape like this (Fig. 9).

Fig. 9.



The velocity of the water is greater the nearer it is to the centre. The pressure is greater the farther away from the centre. The spiral motion which you observe in this case s the only steady motion of water which allows a constant radial discharge without the water making objections, setting up little eddies of its own, and thus wasting energy in friction.

Hence, in Thomson's pump, after the water is discharged, it circulates in this cylindric whirlpool chamber, which he made of twice the diameter of his wheel. When a pound of water reaches this place, in consequence of its radial and circular motions, it retains more nearly the whole of its total energy than if we let it discharge in any other way. It has lost much of its velocity, but has gained in pressure. This whirlpool chamber of Thomson's, then, did for the water what these gradual curves do for the water in this pipe, it enables the water to convert its kinetic into pressure energy, with a minimum of waste in friction.

It has, however, to be remembered that even here at A, the water retains a very considerable amount of kinetic energy, even when the whirlpool chamber is made very large, and much of this is wasted afterwards. And, although no one believes more firmly in the reasoning of Thomson, I feel that perhaps the whole problem admits of a better common-sense solution. Let the whirlpool chamber get wider or broader as well as larger in diameter. Let the wheel have larger orifices on its outer circumference than on its inner circumference. The water will lose its kinetic energy far more rapidly as its passage widens more rapidly. The result of this will be that although in this rapid change there is more friction, yet when the water is only a short distance out, it is not moving much faster than it will do in the discharge-pipe, and there is much less loss in entering the discharge-pipe.

I have always thought that since Thomson's chamber cannot be made very large indeed, we ought to submit to a modification of the theoretically perfect conditions even from the place water leaves the wheel. Inasmuch as the pumps of Gwynne and Appold are not so very much lower in efficiency than Thomson's, their want of a true whirlpool chamber seems to be made up for by a rough approach to the shape of discharge chamber I have suggested. Such a discharge chamber is less efficient certainly than a very large whirlpool chamber would be, but it may be made more efficient than such whirlpool chambers as are not inconveniently large.

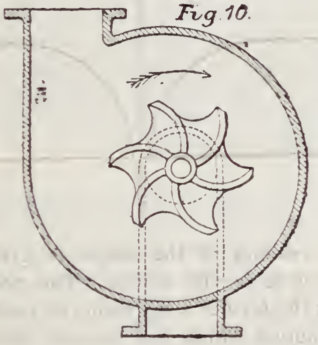


Fig 10.

My rule is, give larger discharge chambers to pumps than Gwynne and Appold do, but do not think it absolutely necessary to give great space radially. In fact, ease the water-flow from the wheel, not merely by giving large radial space, but also, laterally, taking care that the lateral easement is regular, and let it be as slow as convenience will allow. Remember, too, that there is much friction against fixed sides of whirlpool chambers if Thomson's idea is thoroughly carried out.

[Several diagrams were shown illustrating this method of lateral easement from the wheel chamber to the discharge pipe.]

Miscellaneous.

PETROLEUM SUPPLY.

A correspondent of the *Times* in Philadelphia, has given a full account of the present sources of supply of petroleum, from which it appears that the present production is almost entirely confined to a few counties of north-western Pennsylvania. The production has now advanced until it has become the third in value of the exports of the United States, being exceeded only by cotton and breadstuffs. This is all the growth of barely a score of years, and since the first oil well was sunk in 1859 the product of the wells is estimated as adding 1,500,000,000 dols. to the wealth of the country, mainly contributed by the foreign consumers, for the oil is sent to all parts of the world.

The steadily-increasing consumption has made the production also increase, until last year it was nearly 27,000,000 barrels, while the export trade has averaged over 1,000,000 gallons daily. The consumption is now estimated at 71,000 barrels daily, and the production at 80,000 barrels, while the stock on hand is reported about 30,000,000 barrels. During the first five months of this year 159 millions of gallons were sent abroad, compared with 123½ millions in the same period last year. China, Japan, and the East Indies constantly increase their demand for petroleum, and England and Germany are also steady users, while vast quantities go to the Mediterranean.

The oil-producing territory has been confined practically to the counties of Butler, Armstrong, Clarion, Venango, Crawford, Bradford, Forest, Warren, and M'Kean, in north-western Pennsylvania. In the first six of these counties the available territory is already exhausted. M'Kean county is declining, its productive surface being clearly defined and more than half exhausted, while the oil product of the future will be yielded by Warren and Forest counties, the largest part of which is yet to be tested for virgin oil territory. As petroleum, on account of its cheapness and adaptability, has become the great illuminator for the world, the question is being anxiously asked by many, "How long can the present immense supply be maintained?" The history of the producing region shows that the rich fields are generally exhausted in from one to five years after they are opened. The first wells were in Venango county and along Oil Creek, where now there are many of the once famous and richest oil farms that are not producing a single barrel of oil, or else are furnishing but the briefest fraction of their former great product. Exactly how long before the present rate of pumping will exhaust the Pennsylvania oil fields cannot, of course, be foretold with certainty, but many experienced oil producers do not hesitate to say it will not take as many years to deplete the remaining oil deposits at the current rate of yield as it has taken to bring the product up to the large figures of to-day. The actual extent of producing territory in Pennsylvania—past, present, and prospective—has been well-defined by the drill. The southern limit is in Armstrong and Butler counties, where the oil-bearing rock dips so far below the sea level, that the oil either was never generated there, or else has been forced to higher levels by the salt water contained in the rock. A western line of "wild cat wells," that failed to find anything but gas, has clearly defined the limit to the field on that side, and extends through Butler, Mercer, Crawford, and Erie counties, now the western boundary of Pennsylvania. Similarly, the eastern edge of the field is marked by another cordon of dry wells, in Armstrong, Elk, and Jefferson counties.

The sudden growth and speedy decline of the various producing sections, have had a marked effect upon the towns in north-western Pennsylvania. A journey along Oil Creek, and in other localities, discloses a perfect wilderness of abandoned oil derricks. For instance, the once celebrated petroleum town of Pithole, is now in complete decay. The Pithole well-borers first "struck oil" in May, 1865, and then a fever took possession of the people, that brought several thousand population there in less than two months, and gave it 16,000 population before the end of the year. It rose in greatness until it had 50 hotels, some of them miniature palaces, and one costing 80,000 dols. to build. It had numerous banks and business houses, and miles of busy streets, while its oil transactions reached vast figures. But when barely eight months old, decay began. The neighbouring oil wells gave out, and the town declined as fast as it had grown. Now but one man lives in the place, the railroad has been taken away, and most of the buildings are gone. The old houses remaining are falling to pieces, and corn-fields stretch over the land that was once a region of attractive houses. What are now pasture fields, had then been sold for building lots at the rate of 100,000 dols. an acre, and the old farmer still lives on the hill opposite the town, who refused 700,000 dols. for a farm that two years afterwards he vainly tried to sell for one-hundredth part of that price.

General Notes.

Ehrenfeld Exhibition of Small Industries.—An International Exhibition, intended to be permanent, is being organised at Ehrenfeld, a suburb of Cologne. Exhibitors are to have the option of taking their spaces for a year, or for three, six, or nine years, and may, from time to time, change the articles they exhibit. The classifications includes nine groups or sections, viz., tools, instruments, machines, or appliances connected with domestic economy, horticulture and agriculture, small industries, architecture, the extinction of fires, and life-saving in connection with them, hunting and fishing, and public instruction. Everything connected with large industries, such as mines, ironworks and railways, is excluded, as also are the military art and navigation.

Technological, Industrial, and Sanitary Museum of New South Wales.—The Colonial Government are making rapid progress with the organisation of this Museum, which has now been permanently established in the Garden Palace at Sydney, the building in which the International Exhibition of 1879 was held. Arrangements are now being made for the shipment of contributions to the Museum, from manufacturers in this country, which for the most part consist of sanitary appliances and articles connected with building. These contributions are being forwarded to Sydney free of cost by the Government, on the recommendation of the British committee, at the head of which is Sir Saul Samuel, the agent-general for the colony. Manufacturers and others wishing to avail themselves of this opportunity of sending specimens, models, plans, books, illustrated catalogues, &c., should apply, without delay, to Mr. Mark H. Judge (8, Park-place-villas, Paddington), the acting member of the British committee, for the necessary forms.

Smyrna Raisins.—In the number of this *Journal* for June 9th last, a notice was given of the manufacture of wine from raisins, in France; and since this, some statistics have been published, which show the great increase in the dried fruit trade of Smyrna. Two kinds of raisins are exported from Smyrna—the one under the names of Rosaki and Sultana, for table purposes, the other of a much more ordinary kind, used for distilling and making wine. Of these, some 20,000 tons are annually produced, of which half is consumed in the country. The increase of exportation of this class of fruit into France is shown by the following figures:—1873, 642,000 f.; 1874, 1,052,750f.; 1875, 580,000f.; 1876, 642,000f.; 1878, 2,172,220f.; 1879, 11,041,560 f.; 1880, 14,486,840 f.; 1881, 10,604,360f. The new Customs tariff is likely, it is said, to seriously injure this growing trade, as these ordinary wine-making grapes are now included under the head of table fruit, involving a duty, on entering France, of 6f. per 100 kilogrammes, instead of 30 c., as before. As the price of Rosaki and Sultana fruit is from 60f. to 100f. the 100 kilogrammes, while that of the wine-making fruit is only from 23 f. to 32 f., not only the Smyrna fruit-growers, but the French wine-producers are likely to suffer considerably from this arrangement.

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CANTOR LECTURES.

It has been found necessary to postpone the publication of the third of Prof. Perry's lectures on "Hydraulic Machinery" until next week.

RECENT PROGRESS IN TELEPHONY.*

By William Henry Preece, F.R.S.

The telephone was first introduced to the British public at the meetings of the British Association. In 1876, at Glasgow, Sir William Thomson startled his hearers by announcing that he had heard, in Philadelphia, Shakespeare quoted through an electric wire, by the aid of the invention of Mr. Graham Bell, which he then pronounced to be "the greatest by far of all the marvels of the electric telegraph." In 1877, at Plymouth, I had the pleasure of showing in actual operation the finally developed instrument now known as the Bell telephone, which I had just brought over from America, and conversation was actually maintained between Plymouth and Exeter. Five years have elapsed since then, and it is fitting that the British Association should hear of the progress of this astonishing apparatus.

In 1877, it was a scientific toy; it has new grown to be a practical instrument. £1,550,000 capital is already embarked in its extension in England, and it is earning a revenue of £109,000. Hitherto it has been practically a monopoly in the hands of a private company, who hold the controlling patents, and of the Post-office, who hold the controlling power; but this monopoly has been broken, and we are about to witness severe competition. It is often said that competition in any business will have the effect of reducing the rates charged to the public; but the experience of the past in railways and telegraphs scarcely teaches this lesson. Undue competition tends to lower the rates for a time, but it eventually leads to amalgamation—to the absorption of the weak by the strong—to swollen and watered capital—and, finally, in many instances, to higher rates to a too-confiding public. Competition, however, induces better service, and ultimately, in this respect, the public gain.

The free traffic in patents, however, leads to jobbery and speculation of the worst type. We have recently seen a mania for electric speculations that almost rivals the South Sea Bubble period. The public have wildly rushed into ill-matured schemes, that have swollen the purses of gambling promoters, have turned the heads of inventors, have retarded the true progress of the beneficial application of this new science to the wants of man, and have thrown away millions upon imperfect schemes. Much has been said against the monopoly of the Post-office in telegraphic business, but, at any rate, it has the merit that it has checked the rapacity of company promoters and patent-mongers in that branch of the practical application of electricity, while no one can assert that it has checked the progress of telegraphy. During the first week that the telegraphs in this country were transferred to the State, the total number of messages transmitted was 26,000, while in the week ending August 11th it amounted to 724,000. There is no inventor who can assert that his scheme has not received proper consideration, nor show a real improvement that has not been adopted and remunerated; while the improvements of the Post-office itself are freely adopted by other countries, and America itself—the home of the inventor—has found the advanced system of England worthy of acceptance.

Receivers.—The original telephone receiver of Bell has scarcely been improved upon: it remains in form and construction very nearly the same as that which I exhibited in 1877. The perfection of its working depends upon the truth and perfection of its manufacture. It is now more solid and substantial than it was at first—more powerful magnets are used; but still it is the same simple, marvellous, and beautiful instrument that I brought over from America. Mr. Gower has increased its loudness, by varying the form of its various parts, and using very powerful horseshoe magnets of peculiar form; but experience shows that loudness is always obtained at the expense of clearness of articulation; and, although for many purposes the Gower-Bell instrument, which is adopted by the Post-offices, and is now in use to connect together all the sections of the British Association scattered through the town of Southampton, is more practical, nothing for delicate articulation surpasses the original Bell.

The Paris Exhibition of last year, so fruitful in electrical novelties, did not bring forth any marked improvement in telephonic apparatus. It was noticeable chiefly for its practical applications of the telephone, and particularly to the transmission of singing and music to a distance. M. Ader's modification of Bell's receiver is that almost universally used in Paris. It is a very handy, pretty, and convenient form. He utilises a principle which he calls "superexcitation." A thick ring of soft iron is inserted between the earpiece and the diaphragm, and this is said to increase the attractive power of the little horse-shoe magnet upon the vibrating iron diaphragm. A simple experimental apparatus of M. Ader's shows that there is some foundation for this fact; when a thin steel spring is adjusted close to the poles of a magnet without being attracted by them, the near approach of a mass of iron to the spring will cause it to be attracted by the magnet.

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* Paper read before the Mechanical Section of the British Association, at Southampton.

D'Arsonval also has modified the Bell receiver. He has placed the coil in a powerful magnetic field of annular form, and has thereby concentrated the lines of force upon the induced coil. He brings the whole coil within the influence of the field. The effects are said to be magnified, and the increased loudness is not accompanied by the usual loss of articulation. Speech is reproduced without any change of *timbre*.

Telephone receivers of the Bell type are based upon the magnetic effects of currents of electricity flowing around magnets or bars of soft iron.

The rapid and rhythmic magnetisation and demagnetisation of a bar of iron, or the increment and decrement of the magnetism of a magnet, will produce molecular disturbances in its own mass, and in the matter about it, that lead to the oscillatory motions of the whole, which produce sonorous vibrations that can be made manifest by various devices, and particularly by that patented by Graham Bell.

Other principles of electricity have also been utilised for telephonic receivers.

For instance, Mr. Edison used the electro-chemical effect. The decomposition of a chemical solution in paper or on chalk, by the passage of currents through it, produces a modification of the friction of two moving surfaces, which can reproduce sonorous vibrations, and the result is a very loud-sounding apparatus. I myself had the pleasure, in 1880, of submitting to the Royal Society a receiver based on the electrothermal effects of the current. The passage of a current through wires always heats them, and, therefore produces expansion. If the wire be made fine enough, the heat is generated and dissipated so rapidly, the expansion and contraction are so quick, that sonorous vibrations are the result. Although I was able to speak through it very clearly, I have not as yet developed this instrument into a practical form. Professor Dolbear has recently utilised the electrostatic effects of currents. His receiver is even more simple than that of Bell. Two flat circular discs of metal are rigidly fixed very close to each other in an insulated case of ebonite. When one disc is electrified positively by a charge of electricity, the other is electrified negatively by induction. These two opposite states produce attractions varying in force with the strength of the signals sent, and the result is that, when telephonic currents are transmitted, we obtain sonorous vibrations, and, consequently, the reproduction of speech.

Many other forms of telephone receivers have been devised and exhibited, in fact I have recently seen quite a crop of them; but as they involve no new principle, and introduce no particular improvement, having been brought out chiefly to try to avoid existing patents, I pass them over, and proceed to the next branch of my subject.

Transmitters.—The great novelty and peculiarity of Bell's telephone was that the receiver and transmitter were similar and reversible. Sonorous vibrations of air impinging on an iron disc caused it to vibrate in front of a magnet around one pole of which a portion of an electric circuit was wound. These vibrations of a magnetic substance in a magnetic field produced currents of electricity in the coil of wire on the magnet, varying in strength and direction with the sonorous vibrations, which, proceeding along a wire to a distant station, there varied the magnetic strength of a similar magnet so as to vary its attractive force on a similar disc, and thus, reproducing the sonorous vibrations of the air, repeated speech. The currents, however, were very feeble; much energy was lost *en route*, and the effect scarcely attained a practical standard. Mr. Edison showed how to strengthen these currents. Taking advantage of a peculiar property of carbon, which was supposed to vary in electrical resistance with the amount of pressure brought to bear upon it, he caused the vibrating disc which was spoken against to press upon a button of carbon, and so to vary the strength of a current of electricity passing through it. This varying current, passing through the primary wire of an induction coil, set up in the secondary coil more powerful currents than the Bell instrument produced, and caused louder and more marked effects at the receiving station. Professor Hughes went a step further. He formed a combination of materials that were directly affected by sonorous vibrations, which he called a "microphone," and he proved that the effect of the carbon transmitter of Edison was not due to any influence of varying pressure on the mass of the carbon, but was a phenomenon of loose contact. He found a new fact in nature, and he startled the scientific world by introducing an instrument which did for minute sounds what the microscope had already done for minute objects. By the light thrown on the theory of the instrument by Hughes, Edison's carbon transmitter has been so improved by Blake, Hunnings, Moseley, Anders, and others, that little, apparently, remains to be done. The telephone, as a speaking instrument, is now well-nigh perfect. It is quite possible to swear to a friend's voice at 100 hundred miles distance. The difficulty of making the telephone a practical instrument under all circumstances is not due to any defects in the instrument itself, but to disturbing influences external to it, and consequent on its surroundings. The very perfection and sensitiveness of the apparatus itself are its chief enemies.

The true action of the microphone, or carbon-transmitter, is very little understood: it introduces into a closed electric circuit, through which a current is flowing, a resistance which, varying exactly with the sonorous vibrations impinging upon it, causes the current to undulate in a way exactly analogous to the varying sound waves. This effect is generally assumed to be due to a greater or less intimacy of electrical contact between two semi-conducting surfaces abutting on each other; but there is now little doubt that it is due to effects of heat generated by the passage of electricity between two points in imperfect contact, whose relative distance is variable. Carbon is the best material for the purpose—first, because it is inoxidisable and infusible; secondly, because it is a poor conductor; and, thirdly, because it has the remarkable property of having its resistance lowered when it is heated—the reverse of metals. This observation is due to Mr. Shelford Bidwell.

The resistance of microphones is very variable: some give 10ω, while others give 25ω, and some even 125ω. The best transmitters that I have worked with (Moseley's) give an average of 20ω.

Attempts have been made to apply mathematical analysis to the determination of the best form and arrangement of microphones, but at present the microphone defies mathematics.

Theory would lead to the conclusion that a carbon transmitter should have the lowest possible resistance, but practice does not confirm that idea.

Theory again asserts that the resistance of the secondary coil of the induction coil should be equal to that of the line it works, but practice proves the very reverse. On a line giving nearly 1,800ω resistance, the best effects were produced with a secondary wire of only 30ω resistance. The fact is, that the conditions due to heat in the microphone, and to self-induction in the induction coil, are very complicated, and are not yet sufficiently understood to bring the phenomena they affect within the region of mathematical analysis.

Accessories.—I do not intend to speak here of the bells, calls, switches, &c., used in carrying out telephonic operations: there has been nothing that is particularly novel introduced, or that was not previously used in telegraphy. In fact, the whole operations carried on in connection with the so-called "exchange" working are simply telegraphic, and are still in a somewhat tentative condition.

Long-distance Speaking.—I have said that the difficulty in speaking is chiefly due to the environment of the wires employed. Were we to erect a wire from Land's End to John o' Groats, upon lofty separate poles and away from all other wires, there would be no difficulty whatever in speaking between those two places. Conversation has been held in America over 410 miles; in Persia it has been effected between Tabreez and Tiflis, 390 miles apart; in India, over a distance of nearly 500 miles; in Australia, of 300 miles; but in all these cases it was done either at night or under exceptional circumstances, and in all cases the wires were overground. Had they been underground or submarine, the case would have been very different. Conversations have been held between Dover and Calais, between Dartmouth and Guernsey, and between Holyhead and Dublin, but I know of no case where any persons have spoken through more than 100 miles of submerged cable. The reason of this diminution of speaking distance is due to the electrostatic capacity of the telegraph line, which absorbs the minute quantity of electricity that makes up the currents employed for telephonic purposes.

In every submarine cable, before a signal can be made at the receiving end, the whole cable must be charged up with electricity, and if there be not sufficient electricity sent in to effect this purpose, practically no signal appears at the distant end. With telephone currents on long cables the whole of the electricity is, as it were, swallowed up—that is, none appears at the distant end, or, if it does appear, it is rolled up in one continuous wave, bereft of those rapid variations that reproduce sonorous vibrations. The newspapers said that the sound of the bombardment of Alexandria was heard at Malta; but, in the first place, the experiment was not tried, and, even if it had been tried, it could not have succeeded. The use of underground wires very seriously impedes telephonic extensions, and, with our present apparatus and present knowledge, we cannot readily speak over greater distances than 20 miles.

Disturbances.—But there are other disturbing influences at work of more serious import.

When two or more telephone wires run side by side, what is said on one can be overheard on all the others; and when a telephone wire extends alongside telegraph wires, every current on the telegraph circuit is repeated in the telephone, leading to a hissing, frying, bubbling sound that is not only very irritating, but which on busy lines entirely drowns speech. When music is transmitted on one wire, it can be heard equally well on all wires running parallel and contiguous. This is due to induction and to leakage.

(A.) *Induction.*—Induction is a term employed to designate the peculiar influence which electrified and magnetised bodies exert upon conducting and magnetic masses in their neighbourhood. If two wires run side by side for some distance, every current of electricity sent upon one wire will produce two currents in the contiguous wire, the one at the commencement and the other at the end of the primary current of electricity. The greater the intensity, and the more sudden and abrupt the commencement and the ending of the inducing current, the greater effect it has on the induced wire. Those instruments, consequently, which reverse their currents the most rapidly and suddenly, produce the greatest disturbance. The powerful alternative and intermittent currents used for certain electric light systems are death to telephones: they cause an incessant roar that renders speech an impossibility. There are some apparatus in telegraphy that require very powerful currents to work them, which are equally detrimental. Many attempts have been made to cure this evil.

1. The sensitiveness of the receiver has been reduced to lessen the influence of the disturbing currents, and the strength of the telephonic transmitting currents has been increased so as to overpower the induced currents.

2. The influence of one wire on the other has been

screened off by inserting metal coverings in connection with the earth between them.

3. The suddenness of the rise and fall of the inducing currents has been modified by the insertion of condensers or electro-magnets.

4, Counter-balancing or neutralising effects have been set up by counter-induction apparatus.

But all these plans, and many others, have been proved either only partially successful or wholly abortive; the only effective mode of curing the evil at present practically used is to employ a complete metallic circuit so contrived that the two wires are in very close proximity to each other, or that they twist round each other, so as to maintain a mean average equality of distance between themselves and the disturbing wires. When we have the two wires of a circuit kept at the same mean distance from the disturbing causes, however near they may be, the influence on each must be identically the same, and as the one is used for going and the other for returning, the similar influences must be opposite in direction, and they must therefore neutralise each other. This plan, which was originally devised for underground wires by Mr. Brookes, of Philadelphia, was found to be absolutely true in practice, and the Post-office, having laid down many hundreds of miles on this system with perfect success, invariably constructs its circuits both underground or overground in its way. It is, of course, more expensive than a single wire, but the great gain—the absolute freedom from overhearing, the privacy and the absence of crackling—is well worth the extra cost. Wires in submarine cables are invariably laid up with a twist, so that no special contrivance is needed on such wires, and in underground wires not laid up together as cables they are, as a rule, so close to each other that twisting is unnecessary; but for overground purposes twisting is essential, and special arrangements have to be carried out. Professor Hughes showed how this was to be done, and Messrs. Moseley carried it out practically in the neighbourhood of Manchester. The plan adopted is simply and easily carried out, and entails no practical difficulty whatever.

In the neighbourhood of Manchester there are over 400 miles of over-ground double wire twisted on this plan, worked efficiently and thoroughly. I have spoken to a friend seventy-six miles off, through wires that were erected on poles carrying busily-occupied telegraphic currents, without the least disturbance or difficulty.

(B.) *Leakage.*—The double-wire system is only absolutely effective so long as the insulation is good. The moment insulation fails, connection with the earth is made, and then we have disturbing causes due to currents flowing through the ground, which are increased in proportion to the deterioration of the insulation. Hence, good insulation is essential to telephone working.

The discovery of the telephone has made us acquainted with another phenomenon. It has enabled us to establish beyond doubt the fact that currents of electricity actually traverse the earth's crust. The theory that the earth acts as a great reservoir for electricity may be placed in the physicist's waste-paper basket, with phlogiston, the materiality of light, and other hypotheses. Telephones have been fixed upon a wire passing from the ground-floor to the top floor of a large building, the gas pipes being used as a return, and the Morse signals sent from a telegraph office 250 yards away have been distinctly read; in fact, if the gas and water systems be used, it is impossible to exclude telegraphic signals from the telephone circuit. There are several cases on record of telephone circuits miles away from any telegraph wires, but in a line with the earth terminals, picking up telegraphic signals. When an electric light system uses the earth, it is stoppage to all telephonic communication in its neighbourhood. The whole telephonic communication of Manchester was one day broken down from this cause, and in the City of London the effect was at one time so strong as not only to destroy telephonic communication, but to ring the bells. A telephone circuit using the earth for return acts as a shunt to the earth, picking up the currents that are passing, in proportion to the relative resistances of the earth and the wire. The earth offers resistance, and consequently obeys the law of Ohm; hence it is not only essential for a telephonic system that the earth should not be used on any electric light system, but it is also desirable that the earth should be eschewed for telephonic purposes. Thus, the double-wire system adopted by the Post-office, and by the Société Génerale des Telephones of Paris, not only cures the ill-effects of induction, but it materially diminishes the disturbing influences of earth conduction. The four-wire system of the Post-office effectually checks leakage from one wire to the others—cross contact, as we call it in England—for each wire of the same current is always on a different supporting arm.

A telephone circuit when in connection with the earth gives distinct evidence of every visible flash of lightning, however far off the thunderstorm may be. No difference in time has been observed between seeing the flash and hearing the crash.

It is said that, if a telephone be connected between the gas and water systems of a house, distinct evidence of every flash can be heard. There have been several cases of persons being knocked down while experimenting during a thunderstorm, but no personal injury has been sustained, although the apparatus itself is frequently damaged. In England, at present, we have not found the damage done sufficient to justify the employment of lightning protectors. The use of double wires diminishes the danger to a minimum. On the Continent and in America, however, telephones are invariably protected by lightning arresters, where one wire only is used.

There are certain natural currents flowing through the crust of the earth. They are called "earth" currents, and at times acquire such considerable energy, that with a telephone pressed to each ear, I have been told, although I have not experienced it, the noise made is as though "your brains were boiling." This is due to the intermittent currents produced by the polarisation of the earth plates.

M. Van Rysselberghe has recently spoken between Paris and Brussels upon a wire nearly 200 miles long, which was used at the same time for ordinary telegraphy, but the experiment was made early in the morning (4 a.m.), and was effected by retarding the telegraphic currents, so as to modify the suddenness of their rise and fall, by means of condensers and electro-magnets. I am unable to understand the advantage of any gain in speaking on a wire which is detrimental to telegraphic communication. Speed is of more importance than speech, and we can telegraph much faster than we can speak. In England speed is everything, and we eliminate every influence that retards speed—condensers and electro-magnets in telegraph circuits are out of the question. M. Van Rysselberghe has endeavoured to extend the idea to cure the effects of induction by destroying the main cause of the disturbance—that is, by reducing the sudden rise and fall of the prime telegraph currents; but to do this means to retard telegraphy, and we cannot afford in England to cripple the one system in order to benefit the other.

I have recently tried an extremely interesting experiment between this place (Southampton) and the Isle of Wight, namely, *to communicate across seas and channels without the aid of wires at all.* Large metal plates were immersed in the sea at opposite ends of the Solent, namely, at Portsmouth and Ryde, six miles apart, and Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire passing through Newport; the circuit was completed by the sea, and signals were passed easily so as to read by the Morse system, but speech was not practical.

The telephone is very rapidly gaining ground, and as improvements are effected in its accessories, in its installation, and in its mode of working, its use will still further extend. In Germany it is used very extensively for telegraphic business there being 1,280 stations worked entirely by telephones, but in England it is not possible in the numerous open and public shops employed as post-offices to secure that privacy which the telephone requires, nor have we yet got over our early prejudices, resulting from the errors made through the inability of the instrument in its earlier form to repeat the sibilant sounds. The instruments of the present day (thanks to the improved transmitters), however, transmit "s's" perfectly.

LONDON WATER SUPPLY.

In the *Journal* for August 18, there was given a sketch of the work done during the last fourteen years by the Thames Conservancy Board, which has led to the source at which the water companies draw their supplies from the Thames being now "practically free from sewage contamination." In order to understand the steps which have been taken to secure the supply as actually furnished to houses being also improved, there must be considered not only the improvements in the river itself as affected by "scavenging," and the diversion of direct sewage inflow, but also the improvements in the treatment to which the water is subjected after being taken from it. The improvements in the treatment have been various, and effected by the different companies at different times, but it is only for later years the records of these improvements are compiled, and are continuous. The more important are—(1.) Those improvements which affect the purity of the water—the improvements in the settling reservoirs and the filter beds, and (2) those improvements which affect convenience and the quantity and period of the supply—the improvements in the mains, and the conditions under which they are charged.

Records.—Under the Metropolis Water Act of 1871, a water examiner was appointed by the Board of Trade "to inquire into and report on the quality of the water" supplied by the companies. Major (now Colonel) Frank Bolton received the appointment. He, from the outset, adopted the plan of monthly reports. For the first few months they were made to the Board of Trade in MS., but since May, 1872, they have been printed, and are regularly furnished to the Water Companies, Government Departments, Vestries, Medical Officers of Health, and the Press. Before these monthly reports, the chief public sources of information are the two reports of the General Board of Health, made in 1850 and 1856.

Control of Companies—It was not until Colonel Bolton's appointment in 1871, that the companies were under any inspection at all. They can hardly be said to have ever been under any control, till the passing of the Metropolis Water Act of 1852,* which came into operation on August 31, 1855, three years being allowed for the extensive alterations which the Act involved.† This was the Act which compelled the companies to take their supplies from above Teddington, to filter all the water they supplied, and to cover all reservoirs within a radius of five miles of St. Paul's. It was the first Act applying to all the companies. All previous Acts were private Acts, obtained by the different companies for their own protection as companies originated to supply local wants. The early histories of the companies, down to the passing of this Act, together with extracts from it, will be found in "Notes on Previous Inquiries."‡

Work Done.—The changes which a commercial company has to make to keep pace with growing demand can, perhaps, hardly be classed under the head of improvements: but as this increase makes the improvements at any one period very soon inadequate, this cannot be overlooked in judging of their value.

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* 15 and 16 Vic., cap, 84.

† The Chelsea Company was allowed four years.

‡ Published for the Society by George Bell & Sons, Covent-garden, London, W.C.

The increase in the amount of work the five companies, drawing their supplies from the Thames, have had to do, will be seen from the following figures, which are sufficient to indicate, in a rough manner, the demands that a steadily increasing population have made on them. The East London Company, drawing principally from the Lea, and taking but a small portion of its supply from the Thames (over 36,000,000 gallons from the Lea, and under 3,000,000 gallons from the Thames) is not here included. The figures brought together for comparison are those which show (1) the daily quantity supplied, expressed in millions of gallons; (2) the number of tenements to which the water is supplied; and (3) the number of miles of mains and service-pipes laid by each company; (4) the population supplied in 1881.

The only explanation needed for these tables is that "1850" stands for return of the Company to the General Board of Health at that date; "1856" means reports to the General Board of Health (on improvements to end of 1855), made by officers of the Board in 1856; and "1881" means the monthly report made by Col. Bolton to the Local Government Board for December, 1881—that month being selected to coincide with the date at which the report of Conservancy Board is made up.

TABLE I.—AVERAGE SUPPLY EXPRESSED IN MILLIONS OF GALLONS PER 24 HOURS.

Grand Junction Company.

1850	no return
1856	6,714
1881	11,595,632

Southwark and Vauxhall Company.

1850	—
1856	10,331
1881	20,949,710

West Middlesex Company.

1850	—
1856	6,895
1881	10,855,351

Lambeth Company.

1850	—
1856	6,109
1881	15,526,900

Chelsea Company.

1850	—
1856	5,323
1881	7,940,000

TABLE II.—NUMBER OF TENEMENTS SUPPLIED.

Grand Junction Company.

1850	—
1856	14,058
1881	44,616

Southwark and Vauxhall Company.

1850	34,864
1856	41,529
1881	95,782

West Middlesex Company.

1850	24,480
1856	25,732
1881	58,827

Lambeth Company.

1850	23,396
1856	28,541
1881	69,123

Chelsea Company.

1850	20,996
1856	25,050
1881	31,213

TABLE III.—NUMBER OF MILES OF MAINS AND SERVICE PIPES, VARYING FROM INCHES TO INCHES.

Grand Junction Company.

1850	80
1856	117
1881	325

Southwark and Vauxhall Company.

1850	380
1856	432
1881	684

West Middlesex Company.

1850	150
1855	178
1881	384

Lambeth Company.

1850	135
1855	206
1881	500

Chelsea Company.

1850	134
1855	198
1881	209

TABLE IV.—ESTIMATED POPULATION SUPPLIED BY EACH COMPANY IN 1881, EXPRESSED IN THOUSANDS.

Grand Junction	389
Southwark and Vauxhall	689
West Middlesex	423
Lambeth	465
Chelsea	246

No. 1, "the quantity supplied," is, perhaps, the most exact test of the magnitude of a company's work, but Nos. 2 and 3 are not unimportant when the wants of a population are considered. Though the word "tenement" is employed to describe large buildings, factories, and workshops, and conveys no indication of amount supplied, it is also used for small houses, and cottages, where this "prime necessity of life" is as important to the few inmates as it is in larger buildings. Convenient distribution is hardly second in importance to the amount supplied, as the cleanliness of a population depends, perhaps, more on the ease with which water can be obtained, than on overcoming lazy habits in order to get it and use it. When water has to be carried along a court, or street, there is a show of excuse for dirt accumulation. Where it is easily accessible, even to the feeble and the young, the presence of dirt shows a want of appreciation of the importance of cleanliness. While Tables III. and IV. show how well the companies have acted up to their duties in distributing water, there are no means of telling what proportion of tenements have no distribution of water *within* the tenement itself. Not only are there a large proportion of houses with only one cistern, often on the ground-floor, but there are also a proportion, not so large happily, where the supply is only in the back yard. This condition of water supply over which the companies have no control is alluded to for the purpose of drawing attention to the fact that private people—owners of houses—do not follow up the action taken by public companies.* For domestic water supply to be what it should be, improvement in the future lies not so much with companies, whose officials are acting with a right public spirit, however culpable their predecessors may have been, as it does with owners of houses. On the subject of the internal arrangements of houses there are no statistics. Each Englishman's "home is his castle," and, if he wills it, may be kept as foul as a dirty pig-sty of the "good old times," and may have no water supply at all. The statistics available can, therefore, show only what the companies have done in putting the water—abundant in supply, cleared as far as can be from settlement, and filtered sometimes "efficiently" sometimes "not efficiently"—within the reach of thousands crowded into acreage where few dwelt before, so that it can be obtained with at least the same ease as it could be from the old well and pump system. To judge of the work of the companies fairly, theirs must not be regarded as a competition against the old well system, for the statisticians' facts tell how the shallow well supply could not meet the wants of the growing population, and the geologists' facts give but small hope that, even with deep wells, the London basin could of itself supply all the wants of those living above it. The Thames was the handiest alternative.

Improvements in Filtration.—To understand the practical value of improvements of filter-beds, carried out by different companies in different ways, it is necessary to know what it is upon which improvements have been made. As to what remains to be done, we do not know what the construction of an "efficent filter" should be, and the extent of perfection to be aimed at is a matter of opinion. The filtration of Thames water, some 25 years ago, may be regarded as the earlier stages of experiment. Even now, after years of experiment, neither the chemist, physicist, nor the engineer, can decide what "efficient" filtration is, and the Act of Parliament* which required the companies to filter before delivery, gives no definition of what "efficient filtration" shall mean. In the whole range of waterworks arrangements there is nothing more uncertain than what filter-beds will do, and there is no standard so ill-defined as "efficient filtration." "Standard of purity" is of course still less defined, but that is not a waterworks consideration alone. The original source of the supply has to be studied with regard to this. An important step, directing attention to what may be the lines on which a "standard of filtration" may be based, is the collection of the experiences of the different companies, which is thus summarised by Colonel Bolton. Writing, in 1881, he says, "It has been found, during the past nine years, that when the rate of filtration does not exceed 540 gallons per square yard of filter-bed each 24 hours, the filtration is effectual, and this has been generally recognised as a tentative standard rate of filtration." Two points of incompleteness suggest themselves here, in accepting this. 1st. Square yards have no relation to the thickness or composition of the filter-beds. "Cubic yards" would be a surer guide. 2nd. The relative efficiency of a newly cleaned or a fouled filter-bed is not taken into account.

The facts, with regard to the filtration of Thames water, are briefly these. Before the passing of the Metropolis Water Act of 1852, considerably more than half the supply was not filtered, aud this was at the time the supplies were drawn from the highly polluted part of the river. According to the return made in 1850, the existing filters were of sand and gravel of different thickness. Grand Junction, 4 ft.; Southwark and Vauxhall, 5 ft., 6 in.; West Middlesex, none; Lambeth, 7 ft.; Chelsea, 8 ft. The Metropolis Water Act of 1852 required not only that the companies should take their supplies from above Teddington-weir, but that all the water should be filtered. Though three years were allowed for carrying out the works, but they were nearly all completed by the beginning of 1856, and between January and July of that year, the "engineering report" was made to the Board of Trade. As the Act of Parliament made no restrictions as to the character of the filter-beds, it was practically left to each separate company to do what its engineers found experimentally to be the best, and they adhered to the plan of constructing them of gravel and sand. The filter-beds, though differing in detail, are all arranged on the same general plan, fine sand on the top, coarser sand, and then gravel. The Lambeth and Chelsea Companies also use shells between the sand and the gravel. The chief improvement was in the increase of their area. On making a comparison of the works of the different companies, the reporting engineers remark, "Various anomalies and disproportions become apparent, which at first sight seem to be irreconcileable, such as the quantity of water supplied, the amount of steam-power provided, the area of reservoirs and filter-beds, and the cost of the works as compared with the number of houses supplied by each of the companies. . . . . These works are, for the most part, the progressive growth of many years, under many professional advisers, working independently. . . . . The only disproportion of the kind to which we consider it desirable to direct special attention, as probably affecting at times the quality of the supplies, is the very small amount of filtering area provided in some of these works, as compared with that of others." No comment on the efficiency of the filter is made, however.

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* In parts of Westminster, for example, the cisterns are so small, relative to the number of inhabitants, that houses are often without water for hours together.

* Metropolis Water Act, 1852.

The increase in the areas, since then, is as follows:—

	1856.		1881.	
	Acres.	Feet deep.	Acres.	Feet deep.
Grand Junction..............	7½	5·17	10¾	5·6
Southwark and Vauxhall	6½	4·40	14½	5·6
Lambeth	6	0·75	8	7·
West Middlesex	4½	4·50	10	5·6
Chelsea..........................	2	8·	6¾	8·

That even the present filter-beds do not work uniformly, is seen from Col. Bolton's monthly report, where the daily condition of the water is shown. Looking at a series of the monthly returns, the letters C., S.T., T., V.T., standing for clear, slightly turbid, turbid, and very turbid, are seen to occur in an irregular manner, no two companies being alike, and as they all draw from so close to one another, it cannot be the character of the water at the intake that causes this. All the companies have large subsiding reservoirs, so that the water is cleared of much of the suspended matter before it is passed to the filter-beds. Some of them, too, do not draw in supplies at all during floods. Except that it may be in some way connected with the cleaning of the beds, or, as Col. Bolton suggests, in the laying or repairing of mains, the delivery of turbid water at different times seems not to follow any law yet formulated. The fact, however, remains that every now and then the water of one company or another is reported as "unfit for dietetic use," but, unlike the warnings issued by the Meteorological-office, the information is not given to the public till some six or seven weeks after the event. As regards the periods of cleaning of the filter-beds, there does not appear to be any fixed rule.

From the earliest examination of the Thames water, chemists have been of opinion that the water is itself suitable for a drinking supply. The Commissioners of 1828 reported that the "water of the Thames, when free from extraneous substances, is in a state of considerable purity." The doubt seemed to be how to get rid of these. That this can be, and has been done, is seen from the much larger proportion of "clear" than "slightly turbid" supplies on each day in each month's returns.

Constant Supply.—A very important feature in the distribution of water is the gradual introduction of the constant supply system. Colonel Bolton continually refers to it in his monthly reports, as the cure for the evils of cisterns and water-butts, which are, in too many instances, not cleansed, and therefore cause a deterioration in the quality of the water. Many who do have their cisterns regularly cleansed, regard this further clearing of the water by settlement as an improvement. But it is difficult to estimate how much of the settlement in cisterns is deposited from atmospheric dust. The extent to which the constant supply is furnished by companies, is shown by the number of miles of mains in the metropolis constantly charged in each district. Grand Junction, 36; Southwark and Vauxhall, 117; West Middlesex, 82; Lambeth, 70; Chelsea, 64.

The following table shows the growth of the introduction of the constant supply system within the last five years, as indicated by the number of tenements supplied. The returns are made up to December in each year:—

	1873	1877	1878	1879	1880	1881
Grand Junction..	none	none	none	none	502	13,139
Southwark and Vauxhall......	400	450	450	610	2,615	3,024
West Middlesex.	153	2,135	2,902	4,080	7,248	9,121
Lambeth...........	3,000	3,000	4,200	6,230	13,094	17,250
Chelsea	100 special services	100	666	941	1,573	2,191

⁂ The West Middlesex was the only company that extended the system between 1873 and 1877, with the exception of 50 tenements supplied by the Southwark and Vauxhall Companies.

Supplies for other than Domestic Purposes.—A suggestion has been often brought before the public that there should be two supplies in each district, so that filtered water shall not be wasted for street purposes and flushing, &c. None of the companies drawing from the Thames have yet adopted this plan, though the New River Company use between one and two million gallons a day for such purposes.

It is estimated that the proportion of supplies of each company not used for domestic purposes is as follows:—Southwark and Vauxhall, 15 to 20; West Middlesex, 11; Lambeth, 25; Chelsea, 15; all calculated "exclusive of waste." For the Grand Junction there is no return.

Chemical Examination of Water.—With the exception of the report for ten months of last year, by Messrs. Crookes, Odling, and Tidy, there are no generalised reports, and the only analyses given regularly in Colonel Bolton's monthly reports are those by Professor Frankland, made on samples taken one day in each month only.

ROYAL AGRICULTURAL SOCIETY'S MEETING AT READING.

The ground for the Royal Agricultural Society's Show, at Reading, was laid down to grass, in a few months, by Messrs. Sutton and Sons, of Reading; and practical trials were made of the Neilson system of harvesting in the stack. It is said to be a mistake to stack the hay on the same day it is cut; but the artifical system appears capable of saving one or two days drying on the ground. That is to say, if the hay is about three parts cured, the fan may be expected to do the rest. The practice recommended by Mr. Charles D. Phillips, of Newport, Mon., is to let the hay in the stack ferment to 150° Fahr., and then reduce to 100°, and so on, day by day, until a permanent temperature of 70° is attained. Besides exhausting fans, to be driven by hand, horses, or power, this exhibitor showed his flanged wrought-iron piping, with galvanised sliding pipes for connecting the fan, so as to operate on a series of ricks; and his damper boxes containing no square corners for causing friction to the air current. The Royal Agricultural Society themselves exhibited Mr. Neilson's arrangement of fan for drying hay and corn in the stack; and Mr. W. A. Gibbs, of Chingford, had on view working models of his harvest-saving, field-drying apparatus. The great interest taken in this important subject is shown by the number of fans, &c., exhibited and entered for actual trial.

Although shown chiefly in its application to hay, the fan-drying system is also applicable to cereal crops; and indications are not wanting of the gradual introduction of the Hungarian system of grinding corn by rollers instead of between stones. It is obvious that the flour is less heated, and therefore less liable to ferment, in passing between a pair of cylinders, with a minimum of contact, than in describing several rotations of gradually increasing diameter, between the stones. Messrs. Herbert and Law, Edinburgh, showed their roller mills in practical work. The wheat is passed through a pair of "first break" steel rollers, cut with spiral grooves, for opening the grain, at the same time extracting a small proportion of the flour. The bruised grains then pass through a mill with two pairs of smooth chilled steel rollers, which separate the flour from the bran. After the necessary "dressing," the bran is passed through a third pair of rollers with fine flutes, for removing all the flour that still adheres to it. Although, by this process, the bran does not fetch quite such a high price as that made by stones, the more important part, the flour, is finer and whiter, and possesses a higher nutritive value, because not subject to the incipient stage of fermentation. Powerful magnets are used to intercept any particles of iron that might otherwise pass out with the flour.

The extending manufacture and use of small-power motors is worthy of special notice. The original motor, though convenient, was not very economical of gas; and English makers have since improved upon it. Foremost among them comes the Turner Gas Engine Co., of St. Albans, who showed, working, a 2-man, a $\frac{1}{2}$-horse, and a 1-horse gas-engine, in all of which, the heat necessarily developed is turned to account in providing a supply of hot water for domestic or manufacturing purposes. Messrs. Thompson, Sterne and Co., Glasgow, showed at work, Clerk's patent gas-engine, "The Dispressor," in which a pump is used to draw in a mixture of air and gas for the first half of the stroke, and atmospheric air only for the remainder. The object is to render the action more certain and uniform, to clear out the residue of combustion in the cylinder, and to keep the engine cool. A similar principle is adopted by the Ord gas-engine, made by Messrs. Brown and May, Devizes, and exhibited by Messrs. Henry Wurr and Co., London; but in this case, separate pumps are used for the air and gas, serving at the same time as guides for the exhaust-valve spindle. The sizes shown were $\frac{1}{4}$-horse, $\frac{1}{2}$-horse, and 1-horse power. Apparatus for generating gas from petroleum was shown by Mr. H. L. Müller, and the Sun Auto-pneumatic Lighting and Heating Co., the gas, in one or two instances, serving to supply a gas-engine. There were two exhibitors of hot-air engines, for small powers, and suitable for domestic purposes. Messrs. Heywood, Tyler and Co., of London and Luton, showed a $\frac{3}{4}$-horse and a $\frac{1}{2}$-horse power engine, on the Ryder system, which is suitable for a domestic water supply; and Messrs. W. H. Bailey and Co., Salford, their small "Bee" motor, which is heated by a gas-jet, and is suitable for churning, grinding, pumping, &c.

While on the subject of motive power, mention must not be omitted of an application of their bullock-gears, by the Reading Ironworks, (stands 141 and 239). These have been largely used in India, in many parts of which, as Dharwar, bullocks are plentiful, while manual labour is scarce. Dr. Forbes Watson, who has come to the conclusion that a man's power is most advantageously applied by pushing slowly against a bar, breast-high, induced the manufacturers to adapt a bullock-gear for use in one of the Indian prisons, where the men's labour has actually been made to pay the expenses. A sufficient number of poles were fitted to the cap, or socket, for accommodating fifty prisoners, each of whom has to press against a spring, and keep it compressed. If he fail to do so, a signal makes known the fact to the task-master, seated in the centre, who speedily gives a reminder to the man shirking his share of the work. Although all the men have to push with equal force, those on the outside have a larger path to travel through; and, therefore, the men are placed farthest from the centre in proportion to their strength. By means of the multiplying gear, one turn of the cap or socket gives 100 revolutions to the large shaft which projects outside the building, where the power is let for various purposes.

Mr. Thomas Baker, of Newbury, showed, for the first time, his improved cast-iron substitute for the old wooden well-gear of cottages in the country; and in a larger variety, for country mansions, assimilated to the winding gear of a mine. The two buckets, one of which counterbalances the other, tip their contents into a cistern, by a self-acting arrangement. Mr. Edw. Margrett, of Reading, had put down at his stand (No. 100) one of Norton's patent Abyssinian Tube Wells, to the chalk, at a depth of 57 feet; and raised water by means of a new pump specially devised for these wells. The water, cloudy with lime, was made perfectly clear by being passed through a filter, which is claimed to remove dirt, sediment, and mineral impurities, and filters as fast as an ordinary tap will run. It consists of a hollow cylinder of animal charcoal, closed at the ends with blocks, tightly cemented to the upper one, to which an air-tube is fitted. This cylinder is surrounded by common granite chippings, of gradually decreasing fineness, and is enclosed in a Ransome's stone jar, perforated with small tubes, which is inserted in the cistern. It is stated, on the authority of two sanitary engineers, that the question of a continuous water supply has been solved by Messrs. A. H. Bateman and Co., of East Greenwich (Stand 214). The chief objection made by water companies to give a continuous supply is, that great waste ensues from defective taps; that, in poor neighbourhoods especially, tenants will not give notice of defects to the companies, for fear of their supply being stopped; and that the repair of defective taps often involves a discontinuance of the supply of a whole street. At an increased cost of only 15 per cent., Messrs. Bateman make a cock, in which a supplementary stop may be instantaneously screwed up, thus permitting of the working parts to be exposed and set to rights, while all flow of water is prevented. Unless the water supply is very soft, it is still necessary to collect the rain for domestic purposes; and it is very important, in large towns, to exclude the impurities which are so apt to collect on the roof. Mr. C. G. Roberts, of Haslemere (Stand 104), effects this with his rain-water separator, which is a kind of trap, balanced on a pivot. After becoming filled with the first rain which falls, and which may be supposed to wash the roof, it cants and discharges this dirty water into the street or sewer, while all the rest flows into the cistern; and this automatic action is continued as often as the rainfall may cease and recommence.

In the working dairy, the Dairy Supply Co. showed several new appliances, including Mosely's American creamer, an automatic butter printer, a refrigerator and ice safe, a combined milking pan and strainer, a double cased setting-pan, and the improved "Cunningham" butter worker, besides a great variety of churns. Messrs. D. Hald and Co., London, entered for trial the cream separator, manufactured by Mr. Oscar Lamm, Stockholm, which, with a ½-horse power, will separate from 60 to 80 gallons of milk per hour. A. Hamburg Company also entered for trial four sizes of their centrifugal machines, the largest of which skims about 300 gallons of milk per hour; and the Aylesbury Dairy Company the cream separator of Burmeister and Wain, Copenhagen. A "new implement" was also shown in the milking machine of Johan Ernst Nyrop, Copenhagen. The Reading Ironworks exhibited, in action, a machine for cleaning railway milk-cans, technically known as "churns," at the rate of two hundred an hour. It consists of a tank with three large cylindrical brushes, revolving horizontally, side by side. The water is warmed by steam from the engine boiler, some soda being added to act on the grease. The brushes are set in motion by a belt from the engine; and the "churn" is forced over the middle brush. By pressing the bottom down to the bottom of the tank, and allowing it to be turned round slightly from time to time, the whole of the surface, although conical, comes in contact with the brushes; and the "churns" are made perfectly clean. Messrs. Vipan and Headley, Leicester (stand 105), make a useful, light cart, for fetching milk from the railway station, and delivering it to customers. The cans are supported on trunnions, so as to swing, thus preventing a churning of the milk on the rough roads.

Although the Royal Agricultural Society does not, apparently, consider the artificial rearing of poultry sufficiently important to place hydro-incubators under a separate head in the catalogue index, but classes them under "Poultry Yard Requisites," this system appears to be gaining ground in England. There were this year three exhibitors of artificial hatching arrangements, although the French house of Arnould was not represented, as at Kilburn, in 1879. May Arnold, Woking, showed the patent "Aquincubator" egg-oven, and a new brooder, both single and double; and Thomas Christy and Co., London, the "Commercial," the "Cottager," the "Fancier," and the "Henwife" hydro-incubators, the last being new. In order to meet the difficulty and loss of time involved in renewing the hot water, Mr. C. E. Hearson has invented an automatic thermostatic arrangement for maintaining the water at the desired temperature. Near the hot-water reservoir a petroleum lamp burns constantly, its products of combustion passing away freely up a chimney. As long as the temperature of the water exceeds a certain determinable degree, some liquid contained in a metal case remains volatilised, and keeps it expanded; but when the temperature falls below this point, the liquid, being no longer volatilised, allows the case to contract. This action, by means of a rod and multiplying arrangement, closes a damper, and directs the flame of the lamp over the cistern until the desired degree of heat is restored. Mr. William Burch, of Covent-garden, showed the newly-patented "Ovifer" crate, or egg-carrier, made by the Ovifer Spring Packing Co., Glasgow. In the several sizes and varieties of this appliance, the eggs are firmly held in groups of wire springs, and thus require no packing material. They are thus kept clean and free from taint, while the free circulation of the air round each one is said to cause them to keep for a much longer period than when closely surrounded by a packing substance. They are also easily packed and unpacked, and may be safely transported without risk of breakage.

Among the three exhibitors of cooking ranges, that shown in working order by Messrs. T. C. Williams, of Reading, for large establishments, is a new arrangement. It has a steam-jacketed boiler, with provision for turning in hot and cold water, for boiling a hundredweight of beef, and a steam closet or oven, closed tight by screw and hand-wheel, with patent india-rubber joint, for roasting a nearly equal quantity. Moreover, the hot plate will permit of boiling, and other culinary operations; and 150 gallons of water are furnished for bath, &c., in two hours from lighting the fire. Both the fireplace, and consumption of fuel, are remarkably small; and the former can be reduced to half its size, if roasting be required without the steaming arrangement, while still keeping up a supply of hot water. The "Colossus," of J. Rhodes and Sons, Wakefield, a machine that was first shown at the Paris Exhibition of 1878, stamped out tin baking-dishes from the sheet in the presence of visitors; and the Anglo-American Tin-Stamping Co., Stourport, showed a large and varied collection of dairy and domestic utensils made of iron and tin plate, stamped out, and afterwards enamelled. A great objection hitherto made to this ware, which closely resembles earthenware, but does not break with a fall, is that the enamel chips off on receiving a blow; but the manager of the company practically demonstrated that this difficulty had been overcome by their process. A new form of pie-dish bears the name of the "cook's comfort," being provided with a rim for preventing juice from boiling over. A new oven thermometer, after the pattern of the School of Cookery, South Kensington, has been brought out by Messrs. Joseph Davis and Co., London and Southport. The graduations are made on the tube itself, so that a new tube may be inserted by unskilled hands in the event of accident; and a vacuum chamber is provided to prevent bursting at high temperatures by the vapour given off by the quicksilver. The frame bears a table of various articles of food, with the proper temperature to "put in" and "take out" at.

Consideration of space forbids more than a passing mention of the new cardboard and canvass roofing, impregnated with sulphate of copper, shown by the Water-proof Paper and Canvas Co., Willesden; the cleaning step-ladder, with pail attachment, of Messrs. John C. Plimpton and Co., Liverpool; Taylor's safety saw-guard; Avery's registering weighing-machines, on the principle of M. Chameroy, Paris; and a new combined tent and hammock, "The Trestle Cot," of Mr. Benjamin Edgington, Southwark.

PATENT-LAW.

The following is the report of the standing committee of the British Association, appointed "for the purpose of watching and reporting on patent legislation":—

The Committee have no actual progress in patent legislation to report. The Bill promised in the Queen's Speech, and, as was stated by Mr. Chamberlain, to be prepared by the Board of Trade, was not even introduced.

Two Bills for the reform of the Patent-law were brought in during the Session by private members. One of these was by Mr. Anderson, and was generally similar to the Bills brought in by the same gentleman in 1880 and in 1881 (*see* "B. A. Reports," 1880, p. 318, and 1881, p. 222), but contains one important alteration. It provides an examination into the novelty of the invention, with the object apparently of giving friendly advice to the patentee. Mr. Anderson has also materially modified in this year's Bill the schedule of fees to be paid. This Bill was only read a first time.

The second of the two Bills was the one prepared by the Society of Arts, and fully described in the last report of this Committee (*see* "B.A. Reports," 1881, p. 222). It was introduced by Sir John Lubbock, Mr. W. H. Smith, and Mr. J. C. Lawrance, Q.C. It was read a first time on March 15, and a second time on April 28, Sir John Lubbock stating, on the latter occasion, that should the House assent to the second reading of the Bill, he would defer further action, in order to move that the Bill should be referred to the Committee to which it was understood the Government Patent Bill, when introduced, would be referred. As above stated, the Government measure never saw the light at all, and consequently no further progress was made with the Society of Arts Bill. The Council of that Society announce in their annual report that they will endeavour to bring the Bill forward again next year.

Most of the provisions of the Bill, as introduced, are identical with those of the original draft, an abstract of which was given in the report of this Committee last year. Consequent, however, upon the public discussion of the Bill, the Society of Arts made certain alterations in some of their original proposals. The fees were slightly reduced, and the definition of "subject-matter" was modified. The most important change, however, referred to the proposed method of trying patent actions. The new

Court, which the Bill, as first drafted, set up for this purpose, disappeared from the Bill in its final shape, and in place of this provision was inserted one by which the Commissioners of Patents (to be appointed under the Bill) would be empowered to act as assessors, or as referees, or as arbitrators, under certain specified conditions.

It may be worth noting that the Bill had the advantage of being introduced by the President of the Association, while the President-elect (Dr. Siemens) is one of the Society of Arts Committee which prepared the Bill.

STATISTICS OF SILK PRODUCTION IN FRANCE.

The production of silk in France dates from the commencement of the seventeenth century, but it is only from the middle of the eighteenth century that sufficient information is obtainable to estimate its real importance. From 1760 to 1780, the annual average crop of cocoons amounted to 14,520,000 lbs., representing a value of £660,000. After the revolution of 1789, the production was neglected, on account of the introduction of cotton at the expense of silk goods. It was not until 1820 to 1830 that a serious revival took place, bringing the annual production up to 23,760,000 lbs., representing a value of £1,770,400. From 1830, the production was very rapidly developed; it attained, from 1841 to 1845, an annual average of 38,500,000 lbs., yielding a total revenue of £2,660,000 yearly. The greatest production, however, was in 1853, in which year it rose to 57,200,000 lbs., valued at £4,680,000. After 1865, the disease of the silkworm, which had already existed for some time, reduced the crop of cocoons to 16,500,000 lbs., but the price at that critical moment being about 3s. a pound, the revenue obtained amounted to £2,475,000. During the past fifteen years, the crop has experienced enormous fluctuations, from 36,160,000 lbs. in 1866, it fell to 17,768,000 lbs. in 1869; in 1870 and 1871 it rose again to 22,000,000 lbs. During the three following years it fell from 19,800,000 lbs., to 17,600,000 lbs.; and in 1875 attained 24,000,000 lbs. In 1876 it fell to 5,280,000 lbs.; and in 1877, the amount exceeded 26,400,000 lbs. Finally, the production, in 1878, amounted to 17,600,000 lbs.; in 1879, to 11,000,000 lbs.; and, in 1880, to 14,300,000 lbs.

General Notes.

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Paris Acclimatisation Society.—Among the medals and prizes awarded by the Acclimatisation Society of Paris, at its annual meeting, were a gold medal to Sir James R. G. Maitland, of Sauchie, near Stirling, for his establishment of fish culture; a silver medal to Mr. James E. Harting, for his work on "Ostrich Farming and Historical Researches on the Extinct Animals of Great Britain;" a silver medal to Mr. Harvie Brown, for his work on "The Re-introduction of the Capercalzie into Scotland;" and a sum of 300 francs to Mr. Alfred Wailly, of London, for his successful labours in breeding and crossing exotic silkworms, which have been reported in detail in the *Journal*.

Hybrid Silk Moth.—Reference was made in the number of the *Journal* for 30th of June last, to a new hybrid silk moth which Mr. Wailly had obtained from the pairing of *Attacus Pernyi*, the Himalayan oak silkworm, and *A. Roylei*, the North China oak silkworm. In spite of the bad weather and the meagreness of foliage, Mr. Wailly has succeeded in rearing a large number of these silkworms in the open air, in his garden in the Clapham-road. Besides these oak feeders, the *A. Pernyi*, *A. Roylei*, and the hybrid, there are a large number of others, such as the *Selene* from India, which is found to feed on various trees. Mr. Wailly proposes to draw up a report on these silk-producing Bombyces, as in previous years.

Painting on Silk.—Some years ago an artist of Florence employed a method of painting on silk and other fine fabrics, in such a way that the surfaces of the colours were not damaged when folded or rubbed. His paintings, even when subjected to tests far more severe than such crumpling as ordinary wear would produce, are said to retain their appearance unchanged, the colours remaining as bright and the surface as smooth as when first laid on by the brush. The method is now no longer the complete secret it was, as the medium is at present manufacturered for amateurs, though protected by patent. An example, consisting of groups of flowers, painted on blue satin, by this Adolfi process, shown by Mr. Emil Dünki, has been subjected to hard rubbing, without their being any appearance of injury to the painting. Some Italian artists have tried the medium for oil-painting on canvas.

Decoration of Glass and Porcelain.—Three processes connected with the ornamentation of glass, porcelain, and earthenware, were lately brought before the Société de Encouragement, Paris. M. Cacault, of Colombes, prints, on the fine and hard earthenware of Creil, photographic impressions, which are fixed at a single burning. M. Lacroix, Paris, has produced pencils like those of plumbago, but consisting of various vitrifiable colours. A design executed with them, on glass, having the surface slightly dulled, stands the fire, and becomes fixed, like a painting on glass. A similar process, tried on porcelain a few years ago, is said not to have been successful. M. Lutz-Knechtle, a Swiss, decorates glass, cold, by his composition, made of a solution of silicate of soda or potassium, with the addition of zinc-white or ultramarine. The colours are applied by means of a stamp or roller, dry quickly, and stand washing.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

HYDRAULIC MACHINERY.

By Professor Perry.

Lecture III.—Delivered March 20th, 1882.

In my last lecture I pointed out to you the importance of the fact that, when water was in steady motion from one place to another, if we consider that gravity is the only force acting on it, then the whole store of energy in a pound of water consists of:—

Potential, h foot-pounds, because it is h feet above some datum level.

Pressure, $2{\cdot}3\,p$ foot-pounds, because the pressure is p pounds per square inch.

Kinetic, $v^2 \div 64{\cdot}4$ foot-pounds, because there is a velocity of v feet per second.

And however any of these stores may alter, the sum of all three remains constant, except that there is a loss at every place which is proportional to the kinetic energy. If at any place other forces than that of gravity act, we have a change in the total store, and we saw what this is in the case of pumps. Each pound of water gets an increased store of energy, which may be in the shape of pressure energy, or kinetic energy, or both, but which mainly becomes potential.

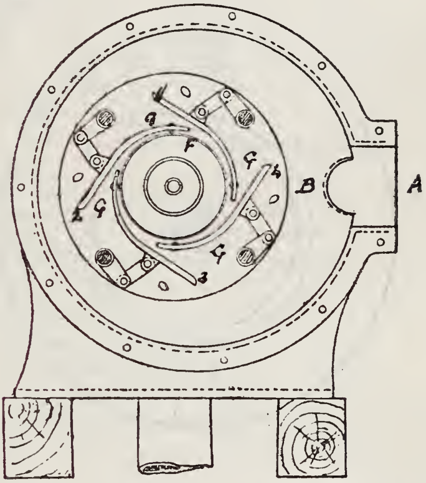
Now, in water-wheels, turbines, water-pressure engines, including hoists and lifts, we take part of the store of energy from each pound of water, giving it to machinery.

As a simple case of the abstraction of energy from water, and as an illustration of the acrobat and railway-train principle which I gave you in my last lecture, consider this vessel from which the water is flowing. Water leaves this vessel horizontally from an orifice, taking away with it momentum. The quantity of momentum it takes away per second is simply the force acting on the vessel. You see that there is a force acting, for I have arranged the vessel as the bob of a pendulum.

If we let the water come from an orifice which allows it to flow in parallel streams with uniform velocity, it is easy to show that the force acting on the vessel is twice the total pressure which would act on this little sluice when it closes the orifice, and no water is flowing.

It is very strange that some of the soundest writers on this subject imagine the force to be less when the vessel is moving. They forget in their calculation that the water leaving the vessel had at the beginning the motion of the vessel itself. Here is a vessel floating on a pond, and moving under the action of this jet. If I had delicate enough apparatus, I could show you that the force on it is the same as if it were at rest.

Fig. 1.



It is a very different problem to consider the force of propulsion on the steam-ship *Waterwitch*. Here we must consider that the acrobats enter the train as well as leave it. A large centrifugal pump draws water from beneath the ship, and propels it out at the sides and sternwards.

Suppose the water moves through the nozzles with the velocity of 30 feet per second, and that the ship is moving the other way at 20 feet per second, then it is evident that the water has a velocity relatively to the sea of 10 feet per second. The momentum, therefore, of a pound of water is $\frac{1}{32} \times 10$, and this, multiplied by the velocity of the ship, gives 6¼ foot-pounds of energy, which each pound of pumped water imparts to the ship.

It is easy to see that the greatest efficiency is arrived at by letting the water take with it only a very small amount of kinetic energy as it mingles with sea water; that is, by letting the backward nozzle velocity of the water be very little greater than the forward velocity of the ship.

A turbine, water-wheel, or water-power engine, takes energy from each pound of water, and gives it to machinery. You must forgive me if I dwell on the turbine, for I see a magnificent future before it which electricity is opening up. Suppose, for example, that we have water in a tank or dam, and we have a clear fall of sixty feet. Now, when a pound of water is nearly motionless at the surface of the dam, it has just sixty foot pounds more energy than when it is nearly motionless in the tail race at the bottom. A water-power engine of any kind is constructed to abstract this sixty foot-pounds of energy with as little waste in friction as possible. Instead of being at the same pressure in the dam and tail race, we may have the pressure energy much greater beforehand, as well as the potential energy; but in every case we try to take out of a pound of water the total difference of energy. Thus, suppose a pound of water to be motionless in a mill dam sixty feet high above the tail race, we cannot take more from it than sixty foot-to pounds of energy. Suppose a pound of water be motionless sixty feet above the tail race, but that it is also inside an accumulator, where the pressure is 700 lbs. the square inch; we can take from it $60 + 2{\cdot}3 \times 700$, or $60 + 1{,}610$, or 1,670 foot-pounds of work.

If you have understood the action of the centrifugal pump, you will have no difficulty in understanding the action of the turbine. It is because you have studied the centrifugal pump that I mean to dwell upon this turbine of Prof. James Thompson. Water flows from a pen-trough through cast-iron pipes to A. Remember our old rule, these pipes must be bell-mouthed; they must open out gradually into the cistern; they must be as large in diameter as we can conveniently make them. In that case the velocity in the pipes will be small, and, therefore, the friction will be small. Fig. 1 (p. 977) shows a plan of this chamber, B, into which the water flows. This chamber is so large that the velocity here is small, and the water finds its way equally readily into the central space, whether it flows between the guide-blades 1 and 2, or 2 and 3, or 3 and 4, or 4 and 1. Observe that at last we are allowing the water to flow quickly, for the guide-blade chamber is narrow. When the water is just leaving the guide-blades, observe that it flows rapidly; of course it is flowing radially as well as tangentially to the rotating wheel, W, but the tangential motion is equal to that of the wheel.

Fig. 2.

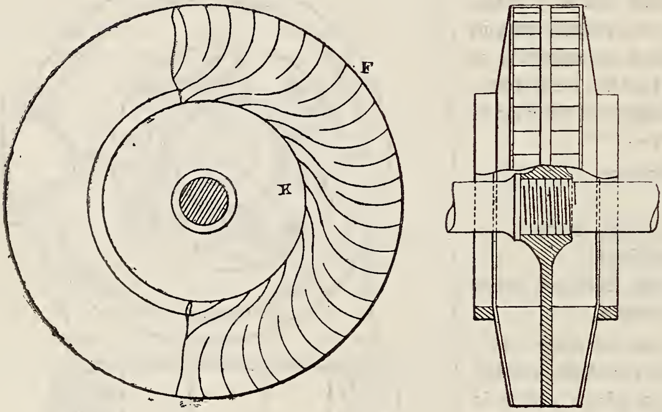
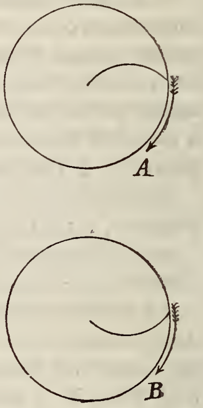


Fig. 3.



Suppose you wanted to enter a railway train without shock, you ought to try to get a velocity equal to that of the train, in the direction of the train's motion, before you ventured to enter the train; hence the tangential velocity of the water must be equal to that of the end of this radial vane of the wheel, if the water is to enter it without shock. If the vane here is inclined like Fig. 3, A, the tangential velocity of the water ought to be less than that of the wheel just here. If the vane here is inclined like Fig. 3, B, the tangential velocity of the water is made greater than that of the vane. In fact, you see that the relative velocity of water and vane must be in the direction of the vane, if there is to be no shock. Usually the vane is shaped as you see it in Fig. 2 (p. 978), which is an enlarged section of the wheel, W; but I will suppose it to be radial just at the outside, for simplicity of calculation. Remember, then, that, somehow or other, we must try to get tangential velocity of water, equal to velocity of vanes there. The water now flows through the wheel, which lets it escape at the centre. Here, again, we must remember that the water has to escape with no velocity, except a radial one.

If we wanted to let a stone out of a railway carriage so that it would just fall to the ground vertically, so that it would possess no forward motion, you know quite well that you would have to shy it backwards, with respect to the train; give it a velocity backwards as much as it has forwards already. These vanes, then, at the centre, let the water out backwards, just because we want the water to have no forward velocity when it has left the wheel. The water has, of course, a radial velocity everywhere, which simply depends on the total quantity flowing per second, divided by the tangential areas of these orifices.

We want, now, to know how much store of energy has each pound of water lost in passing through the wheel, and we employ the rule I told you about before. Get the tangential momentum of the water at F. We have one pound of water, and if the velocity of the outside of the wheel is v, then $1 \div 32 \times v$ is the forward momentum of one pound of water. This, multiplied by v, is the work done by the pound of water, or—

$$v^2 \div 32 \text{ foot-pounds,}$$

because it enters the wheel. Now, you see that the wheel does no work on the water as it leaves at K, because the water leaves with no forward or backward momentum. Hence one pound of water, from the time it enters the wheel to the time it leaves, loses

$$v^2 \div 32 \text{ foot-pounds.}$$

from its store of energy, and gives this store to the wheel.

If then it loses no energy by friction anywhere when it enters the tail race, it has just this much less energy than when it left the pen-trough. If h is the total height of the fall, evidently one pound of water really gives out h foot-pounds of energy. We know that in practice, what it gives to the wheel is only a portion of this, and

$$\frac{v^2}{32} \div h$$

is called the hydraulic efficiency of the turbine. It is the ratio of the energy given to the wheel to the total energy lost by the water in falling from one level to the other. If, then, there is no shock to the water in entering or leaving the wheel, its efficiency is twice the height due to the velocity of the rim divided by the real total fall of the water.

Of course all the energy given to the wheel is not utilised. Remember that there is friction between the wheel covers and the wheel case, friction at all the bearings, &c., of the shafting, which transmits the power of the wheel to a mill, &c. I am only speaking now of the efficiency of the passages through the wheel, which is, however, the most important matter in connection with turbines.

Knowing the average amount of water passing through the wheel, and therefore the radial velocity at K, the angle of the vanes at K is determined if we know the average speed of the wheel. If the speed and quantity of water were exactly proportional to one another; that is, if the speed of the wheel were exactly proportional to the horse-power, the inner ends of the vanes once settled would remain right always. But if our wheel is to be regulated as a steam-engine, so that quickening speed causes less water to flow, then it is obvious that the inner ends of the vanes, although right for the calculated flow, are not properly shaped when the horse-power diminishes or increases. The loss or energy here is not, however, likely to be great in any case.

It is different at the entrance to the wheel F. Unless the guide blades are directed so as to give a tangential velocity to the water equal to that of the wheel, there is a considerable loss by friction at F.

Suppose that less water flows through the turbine, the inclination of the guide blades ought to alter, and this arrangement of links, which you see in the drawing, is for the purpose of making the guide blades alter their inclinations to the wheel. Each guide blade is pivoted at its extremity, K, and when one is shifted they are all shifted in position. Unless there is a great variation in the work which we require a turbine of this kind to do, it is not necessary to apply a governor which partially stops the water supply when the machinery runs a little too quickly, although such governors are very necessary for a great many water-wheels and turbines.

It is to be remembered that this turbine is really a centrifugal pump, through which the water is flowing negatively. Increased speed tends to stop the flow. If the wheel were at rest, the flow would be very much greater than it is. Hence, increasing the speed somewhat stops the flow, allows less water to pass through and less work to be done. This action cannot be called a governor action, for it does not maintain a constant speed, but it may be called a steadying action, as it prevents any great change of speed, even for a considerable alteration in the work done.

Except at the speed for which the positions of the guide-blades are fixed, there is some loss in friction, and the guide-blades are rearranged should any considerable change be meditated in the power to be given out.

I hope to measure the horse-power given out by this turbine.* I have made it drive this absorption dynamometer, which is much the same as the one used by Thomson in gas-engine trials recently. You see that I can measure how much water is flowing; I know the fall, and I can calculate the horse-power of the fall itself, and thus get the efficiency. Of course it is unfair to regard the efficiency of this hastily-arranged turbine as representing in any way the efficiency of a large specimen.

On the large scale I do not care to use absorption dynamometers for measuring horse-power; the heating is too great, unless there is an exceedingly large amount of cooling water used, and the water causes treacherous alterations in friction. I prefer to drive by belting through our transmission dynamometer, or to use this simpler form as a shaft-coupling. You see that if this dynamometer coupling is used instead of an ordinary coupling for two lengths of shaft, the whole torque transmitted through the shaft must be transmitted by these strong spiral springs. The yielding is small, but becomes magnified into a very large yielding of this bright bead. When the coupling is revolving, the position of the bead is well marked on this dark ground, describing large or small circles. Its distance from the centre is readily measurable on scales, which we fix to the wall, or a bracket close in front; and the distance from the centre tells us the transmitted torque. In fact, the reading on the scale, multiplied into the speed, is the horse-power transmitted. Suppose there is a coupling of this kind on any shaft in any room of a factory; the foreman can tell roughly from a distance about how much horse-power is being transmitted, even if he does not care to measure it carefully on the scale. These couplings are more immediately intended for use on dynamo-electric machines, no one of which ought to be driven without such tell-tale of the horse-power given to it; but I consider they would be valuable on turbine shafts; nor would it be difficult to automatically govern the positions of the guide-blades from the yielding of the couplings.

In arranging a turbine, it is obvious that the great point to settle beforehand is this:—What ought to be the speed of the wheel for a given height of fall? If there were no loss in friction, we could say at once, if v is velocity of rim of wheel, $v^2 \div 32$, the total loss of energy by one pound of water, ought to be equal to h; that is, the velocity of the wheel ought to be that due to half the height of the total fall of the water. Thus, for a fall of 60 feet in height, half of this is 30 feet; and if a stone fell 30 feet, it would be falling with a velocity of 43 feet per second. The rim of the wheel ought to have a velocity of 44 feet, then, per second, and it is easy to show that, wherever the turbine may be placed, whether it has a long discharge pipe, or is submerged, as shown in various diagrams and models here before you, the water may be made to flow tangentially into the wheel with the same velocity as the wheel itself has.

But we have usually to calculate on the assumption that a certain fraction of the energy of the water is wasted in the supply and discharge pipes, and the discharge chamber, and hence the velocity of the wheel is less than that due to half the height of the fall.

It is usual to assume that the radial velocity of the water through the wheel is one-eighth of that due to the total fall. Dividing this into the number of cubic feet of water flowing, you know the total tangential area of the space between the vanes everywhere in the wheel, assuming that it is the same everywhere which it usually is. It is usual to take the inner radius of wheel equal to the depth of these passages in the wheel, so that both these dimensions are now fixed. The outer radius is generally twice the inner one, and we have already calculated the tangential velocity of the outside, so the number of revolutions per minute may be calculated. The horse-power given out is usually taken to be less than three-fourths of the true horse-power of the water. Thus, by rules, partly due to practical experience and partly due to imperfect theory, we are able to fix all the dimensions of a turbine of the kind I have been describing.

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* Here various measurements and calculations were made as to the efficiency of the model of Professor Thomson's turbine, working on the lecture-table.

I think that, by entering thus fully into the theory and construction of the turbine, with which I am, myself, practically acquainted, I can dispense with giving a catalogue of the constructions of turbines generally. This turbine is said to be one of "inward radial flow." You see that, for a given quantity of water flowing, it can be made hydraulically perfect, that is, by proper construction of these guide-blades there is no necessary loss of energy, any more than in the whirlpool-chamber of Thomson's centrifugal-pump. Water need not flow from any one place here to any other where there is necessarily, from the shape of the stream lines, a difference in the amount of total energy per pound of water.

You see that, in the same manner, we could discuss the action of water in the unsteady "outward radial flow turbines," and, again, in the axial-flow turbines of Fourneyron and others. The principle of your stream of acrobats jumping on and off a merry-go-round, will in every case tell you how much energy the water gives to the wheel of a turbine, whatever may be the nature of the flow. In the same way, also, we consider the construction of the floats of undershot water-wheels, and all other wheels on which the water acts impulsively; that is, the water possessing only a portion of its store in the shape of pressure or potential energy; much of its energy being kinetic when it is entering the vanes.

I wish I had time also to tell you about the action of air in motion on windmills. The action of air on the sails of a windmill is pretty much the same as its action on this little ventilation gauge; and I hope that some of you will be sufficiently interested in this matter to get these little models of windmills and anemometers explained to you at the end of the lecture.

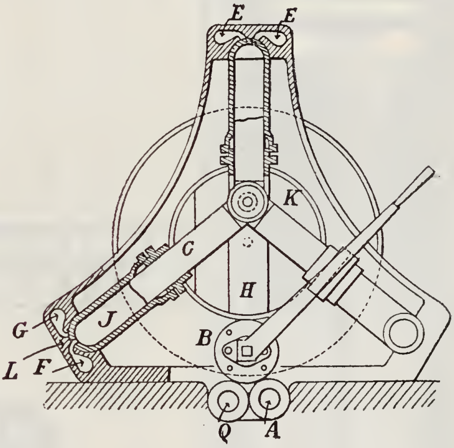
When the available fall is very great, it is not advisable to use a turbine water-wheel. In the turbine, as you saw, there is at least one part of the arrangement in which about half the total store of energy is in the shape of kinetic energy; and when the energy is in the shape of kinetic energy, there is a great waste by friction. The waste is proportional to the kinetic energy, that is, to the total energy, and hence turbines are at least not more economical on high falls than on low ones.

Now, a water pressure engine may be regarded as the inverse of a reciprocating pump. If we neglect the shocks which are always due to imperfect construction, when a water pressure engine works at a certain speed, the loss of energy by friction in the engine is the same on high and low falls, and hence there is a very much greater efficiency on high falls. We employ water pressure engines, therefore, on high falls instead of turbines.

You must remember, however, that in water pressure engines, as in pumps, kinetic energy produced anywhere is almost immediately altogether wasted. Tweddell's punching-machines are almost the only examples in which even a small part of the kinetic energy is converted again into pressure energy.

In this figure you see the construction of one of the simplest forms of water pressure engine. Water enters the arrangement by the pipe, A, when the cock, B, is opened by means of this handle. There are three rams here, all driving the same shaft, but I mean to confine my attention to one of them. The supply of water enters at A, and finds its way to the space F, by means of a passage in the framework of the machine. There is another passage leading to the exhaust spaces, G, and allowing water to flow from these spaces through the discharge pipe, Q. By reversing the handle, F may be made the exhaust space, and G the supply space, and when the handle is in the middle position it acts as a brake, so that, by means of this handle, we can make the engine work in opposite directions, or stop it altogether.

Fig. 4.

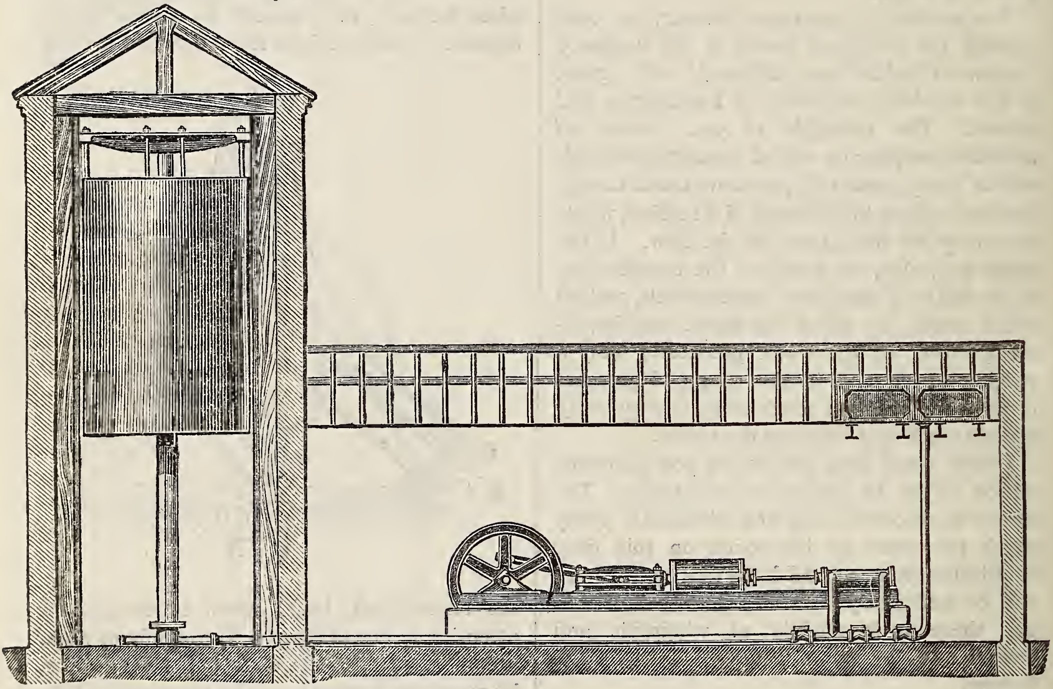


Remember now that water is at F, and fills the space J, and its energy is all pressure energy. It presses on the ram, C, causing it to leave more empty space behind it. You know now how to calculate the force with which the plunger is being pressed. The plunger cannot go out without turning the crank, H K. You observe, too, that as there is no connecting rod, the cylinder, J, turns just like the oscillating cylinder of certain steam-engines. When the crank reaches its dead point, the plunger can go out no further; but when this happens the orifice, L, is just ceasing to let water enter from F, and is beginning to let the water escape into G. As three plungers act on the same crank, the crank does not stop anywhere, and as it moves on, the plunger, C, comes back again, driving the water from J through L into G and away by Q.

This is all exceedingly simple. The quantity of water used in one stroke of C is simply the volume of C which leaves J in one stroke, assuming that the water can come in quite freely. Each pound of this water has a certain amount of pressure energy, which it gives up to the plunger, and which you may take to be the pressure energy in F minus the pressure energy in G. This is only true if we assume that the water has no kinetic energy where it is in contact with the plunger; but as the plunger is itself moving, we know that we are here making a small error. We are also assuming no loss by friction at the passage, L, which is again an error.

So long as J is considerably less than thirty-four feet above the place in the pipe, Q, where there is considerable pressure, it is evident that, neglecting kinetic energy and friction, every pound of water loses 100 foot-pounds of energy in passing from F through J to G, if the total fall is 100 feet. Knowing how many pounds of water enter and leave at one stroke, we have the total energy given to one plunger. Three times this will be the work done on the three plungers in one revolution. This leads to the simple rule. If the total fall is 100 feet, then $100 \div 2\cdot3$ is the pressure per square inch. Call the pressure *p*. If *a* is the area of cross section of the plunger in square inches, *l* the length of the stroke, that is, twice the length of the crank, and *n* the number of revolutions per minute, then the horse power due to *each* plunger is $\frac{p\,l\,a\,n}{33{,}000}$ just as in single-acting steam-engines. This engine is so very simple that one dislikes to draw attention to the fact of there being a great deal of wire-drawing at these slide valves.

Fig. 5.



Engine, Pump, and Accumulator.

You observe that I spoke here of the total fall of the water. Remember, however, that we do not care where the water comes from or goes to; we are really only concerned with the difference between F and G. The water may have flowed from a reservoir, with its surface exposed to that of the atmosphere, but then, again, it may not. Thus, for example, in this model, when I turn this handle, I pump water into a little water-pressure engine, somewhat like the one I have been describing, and the water-pressure engine works, turning the capstan, as you see. When I cease turning, the engine ceases to work; and if the supply-valve of the engine is closed, I find that I can pump no longer.

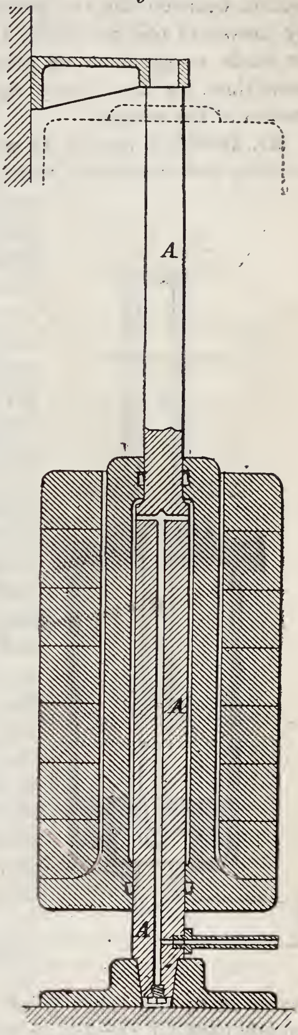
Now, I showed you in my first lecture, that water-pressure engines, moving slowly, can be made very economical; and I mean presently to show you how easily we can work pressure-engines from a steam-engine at a considerable distance. But there would be great difficulty introduced if, every time I stopped my water-engine, whether it was part of a crane, or a capstan like this, or a rivetting-machine, or a punching-machine, or a hoist, my pumps were compelled to stop, and therefore my steam-engine. I want my steam-engine to work continuously, storing energy in the shape of pressure or potential energy in water, so that I may draw on this store intermittently. It is seldom that the energy is stored as the potential energy of water raised to a tank. The usual arrangement for storage is called an accumulator, like this shown in the figure.

Here (Fig. 5, p. 982) is a ram carrying a heavy weight; every pound of water taken from this press possesses a store of pressure energy, which you know how to calculate. The pressure here is the total weight of the ram and accumulator, divided by the cross section of the ram in square inches, and every pound of water leaving this accumulator possesses a store of pressure energy. It may also possess potential energy, due to the accumulator being above the mouth of the discharge-pipe of the water-pressure engine.

For the working of cranes, a pressure of 700 lbs. per square inch is usual. This means that each pound of water has 700 × 2·3 or 1,610 foot-pounds of energy, or as much as if it came from a cistern 1,610 feet high. Instead of coming from such a high cistern, however, it has come from this accumulator, on which the load on the ram is 70,000 lbs., the ram having a cross-section of 100 square-inches. If this ram can be lifted 20 feet high, before the self-acting mechanism shuts off supply from the steam engine pumps, it is capable of receiving a total store of 70,000 × 20, or 1,400,000 foot-pounds; the store of one Faure's Electric Accumulator; enough energy to drive a machine requiring one-horse power for 42 minutes.

As an illustration of the small amount of loss of energy in this form of storage, I quote from Mr. Tweddell, when using an ordinary accumulator with a 7 inch ram, 12 feet stroke. When being charged, the pressure was 1,250 pounds per square inch, and when being discharged the pressure was 1,225 pounds per square inch. So that, in each case, friction is overcome with a pressure of 12½ pounds per square inch, or one per cent. of the energy is wasted in friction in charging or discharging. In fact 98 per cent. of the energy given to such an accumulator is given out again. I am sorry to state, however, that other experienced men state the loss at 20 to 30 per cent., although I know of no recent figures derived from actual experiment which make the loss so great as this.

Fig. 6.

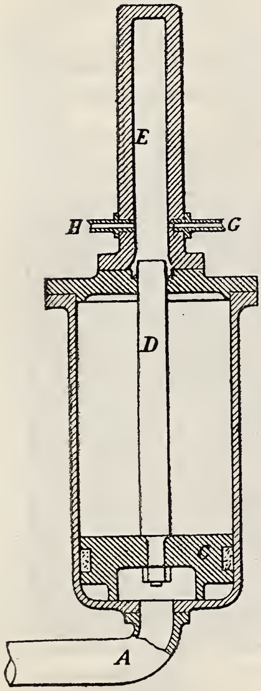


If we want our water to have a greater pressure, we can either increase our lifted weight or diminish the section of our ram. There is a limit, however, beyond which it is unadvisable to lessen the size of the ram when a great weight is being carried, and this is specially the case when the accumulator has to be shifted in position.

Fig. 6 shows a small accumulator of Mr.

Tweddell's, in which the lifted weight contains the heavy press which is usually fixed. Here it is the accumulator ram, A, which is fixed, and it admits water through its centre. But it will be observed that there are two glands; the ram continues right through the cylinder, coming out above, but of a smaller diameter. Hence the total weight may be regarded as giving pressure, not to the area of cross section of the ram, but to the difference of cross section between the two portions of the ram. By means of this principle, the pressure may be made as great as we please, and, at the same time, we have a very rigid guide for the motion of the weight.

Fig. 7.



Mr. Tweddell wanted to work some of his riveting and other tools, which require a water pressure of about 2,000 lbs. per square inch, in shops where there were already in existence accumulators giving a pressure of 700 lbs. per square inch, or where there was a quantity of water at a much smaller pressure than this. He allows his present supply to press on the under side of the piston, C, Fig. 7, and he lets this act on the ram, D, which has, of course, a much smaller cross section. The water in the press, E, will, therefore, have a greater pressure just in the ratio of the area of the piston, C, to the cross section of the ram, D. He pumps in water at G, and takes it off at H, and C is merely used for regulating the pressure in E. He does not waste the supply which comes through A. A empties or fills just as an ordinary accumulator load rises or falls. This, then may be regarded as a great improvement on the ordinary accumulator, as an accumulator in which the weight raised and lowered is a quantity of water in a tank which need not be in the neighbourhood. If the supply-pipes, A, are large, and have easy bends, it is even possible to get from such an accumulator the momentum effect which Mr. Tweddell relies upon for riveting.

In the wall diagram you see a Brotherhood engine working by water instead of steam. Water is admitted and exhausted to and from the outer ends of the three plungers which work on one crank.

In most engines of this kind the work to be done per stroke may be very different at different times, and yet the pressure water used, that is, the energy, is always the same, and so there is considerable loss. Mr. Hastie's method for remedying this evil is to shorten the crank as the work being done is less, and by rather complicated mechanism he effects this purpose.

Another method which has been suggested, is that of admitting pressure water for less than the whole stroke, simply taking water from the discharge-pipe for the remainder. It is probable that this idea will have a large development. When engines have a fixed sort of duty, there is no need for any adjustment.

The common construction of water-pressure engines will be readily understood, if you understand the construction of the steam-engine. Remember, however, that the velocity of water ought never to be great in the engine or pipes. Wire-drawing leads to serious loss by friction in the steam-engine; it is far more serious in water-pressure engines. In these, the valves ought to be quite open, giving a very large passage for water to flow through almost immediately. Hence, although the slide arrangements of Fig. 4 (p. 981) and of some others of these wall diagrams, are allowable in small engines, they cannot be used in large economical engines working constantly. Remember, too, that all frictional losses are made much greater by quick motion, and by reversals of motion, and hence that it is very important to have a long stroke of piston or plunger.

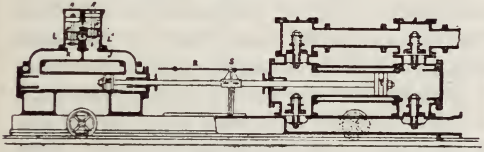
Lastly, remember that, although there ought to be no waste space between steam-piston and cylinder, at the end of the stroke (very little clearance), this is of almost no importance in water-pressure engines, because of the incompressibility of water.

The working of the valves of non-rotative water-pressure engines is always pretty much of the same kind, and it will suffice for all such valves if I describe to you the valves of one of Mr. Davey's engines.

In Fig. 8 (p. 985), water from an accumulator at the top of a mine is admitted alternately on either side of the piston, Z, and exhausts into a pipe, which takes it back again to the surface. The difference of pressure on the two sides of Z is, then, merely the pressure due to the accumulator. The piston-rod becomes the pump-rod, and works (Y) the piston of a double-acting force-pump, which lifts water from the mine, and raises it to the surface. Indeed, the discharge-pipe of the engine is also the discharge-pipe of the pump. The pump, as you see it, has a liner. If this is removed, and a larger piston be fitted on, the pump can discharge twice as much water to half the height. But now I don't want to consider the pump; I want mainly to consider the valves which admit water from the accumulator to one or other side of Z.

As you see, in the valve-case, Fig. 8, water is admitted through F, by the open valve, L, to the space K. The exhaust water is flowing from J, through I, to the pipe G, which is the discharge-pipe. Z is pressed from left to right.

Fig. 8.



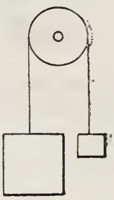
When it gets to the end of its stroke, the rod, R, moves, because the arm, S, strikes a tappet on the rod; the rod, by means of a lever, moves a slide valve, which admits supply water above N¹, and lets the space above N communicate with the exhaust-pipe. You will observe that now there is unbalanced downward force acting on H¹, which falls till the lower part fits its seat, I. The mushroom valve, L¹, continues to fall, and thus the space, J, is at high pressure. But there is more pressure below N than above it, and consequently it rises, closing first the valve, L, and continuing its motion, partly by its momentum and partly by the pressure at K being a little greater than at G, or the space above N, lifts H, and leaves the space, K, in communication with G, the discharge-pipe. Thus we have now J at high pressure, and K at low pressure, and the piston, Z, is pressed from right to left. The valves are reversed in their action at the end of every stroke through the agency of the tappets on the rod, R, and thus the piston will continue moving backward and forward so long as high pressure water is supplied, and so long as the resistance to motion of the pump-piston is not too great.

It will be observed that there is no sudden stoppage of the flow of water from F, for when the main piston is at rest, H or H¹ is falling and letting water flow from F behind it, or behind N or N¹. This affords, then, a partial remedy for the shocks due to change of velocity in the supply and discharge columns of water. Again, the motion is everywhere slow, only twelve double strokes being made per minute.

You must remember that, on account of the comparative incompressibility of water, a sudden stoppage of flow in pipes means a very severe impact. The weight of a ton pressing this hammer against this steel surface might not indent it, whereas the sudden stoppage of the hammer's motion means a tremendous force, quite sufficient to hurt the surface.

You know that this weight, A, cannot lift this weight, B, but if I suddenly stop A's motion, B is raised, as you see.

Fig. 9.



[Some other designs of pumping-engine by Mr. Davey were here shown and explained. The general arrangements are somewhat different, but the valves are just of the same construction.]

What now are the conditions under which transmission of power by hydraulic action is most suitable ?

1st. Intermittent action, because the accumulator is so nearly perfect, giving out energy simply in proportion to the quantity of water used, and yet allowing an engine of small power to be storing continually.

2nd. Action requiring not a very great quantity of power.

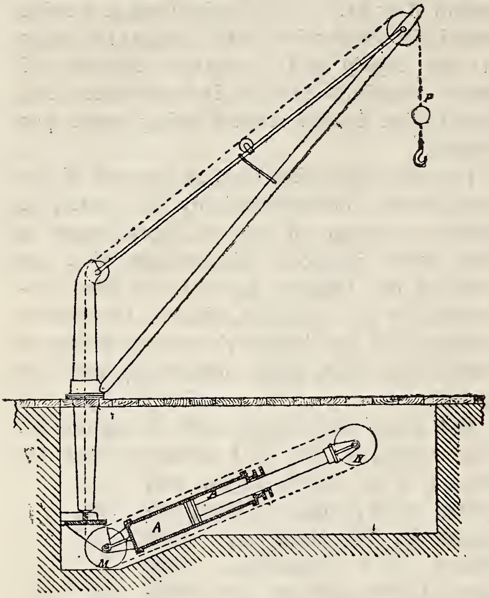
3rd. Action of a comparatively slow kind, the water never being allowed to flow so fast that its store of kinetic energy is great, since the kinetic energy is nearly all wasted. Slow action, with considerable force.

4th. Action which is greatly continuous in one direction, not requiring much stoppage or reversal of the water motion.

You will see from this, that the conditions required in pressing machinery, cranes, hoists, and lifts are better satisfied by hydraulic transmission of power, than they can be by any other method of power transmission which is known to us. You are aware of the fact that pressing machinery can be made to act in a very efficient manner by the agency of water.

In this figure, and in the other wall sheets, you see specimens of the ordinary forms of hydraulic crane, whose action it is very easy to understand. Suppose water at 700 lbs. pressure per square inch admitted to this space, A, and that the space, B, on the other side of the piston, although filled with water, has only a comparatively small pressure, and communicates with a low-lying tank; neglecting the small pressure in B, we see that the piston is pushed forward with a force of $700 \times \frac{\pi d^2}{4}$ or $\frac{700\ \pi d^2}{4}$ lbs. Now the motion of the piston is multiplied eight times by this chain, which passes over blocks, each containing four sheaves, attached at M and N. The block at M gets the motion of the piston, and the chain at P must be drawn in eight times more quickly than this. You saw, from my first lecture, that the pull in the chain may be one eighth as much as the total pressure on the piston, and it can therefore lift through eight times the distance a weight of one-eighth the amount.

Fig. 10.



It is unfortunate that, in modern hydraulic cranes, there has not been much attempt at improvement on the original form of Sir Wm. Armstrong. Whatever defect there is, lies in the use of chains passing over numerous sheaves, giving rise to a great amount of friction. Cranes require so little horse-power to work them, however, that mere economy of coal is barely worth considering, and the risk of accident, which might be done away with very greatly by direct hydraulic action, is not important either. You see that if A and B are communicating with the accumulator, there is less water used than before, for although as much comes into A as before, B is sending water back to the accumulator. In fact, the total pressure on the piston is 700 lbs., and the difference between the areas of the two sides of the piston exposed to pressure, that is, the mere area of cross section of the piston rod. Hence we can work this crane so that it lifts heavy loads or light loads, that is, it is double powered. Unfortunately, however, when working any heavy load, it is consuming as much energy as if it were lifting the heaviest load it is capable of lifting. When lifting on its second power, and lifting a light load, it is using as much energy as if it were lifting the heaviest load this second power is capable of lifting.

Thus, let us suppose it lifting eight tons to a height of 20 ft., and that one cubic foot of water is used in the operation. Then, on the same power, suppose it to be lifting four tons to the same height, it still uses one cubic foot of water, and in both cases there is the same energy drawn from the accumulator. Of course, by a combination of cylinders, like A, B, it would be possible to vary the work expended as the load varied, but the expedient is not of a very practical character. From the scientific point of view, it seems a pity that economy is of so little importance in crane work, for if it had been of importance, I feel sure that large advances would have been made in the last twenty years.

You all know the conditions required in an ordinary hotel or chambers hoist; those conditions are absolutely the same for warehouse hoists, because a hoist which carries goods occasionally carries men in charge of these goods. Long ago, I had some designing and carrying out of mill hoists, in which the cage was lifted by a rope passing over an elevated pulley, driven from the main shafting of the mill, and stopped at any point of ascent or descent by automatic disengaging apparatus which also braked the pulley. The cage was balanced by counter-weights, as a window is balanced. Our greatest trouble was in the arrangement of safety apparatus, which would stop the cage in falling should the rope break. Now it is well known that such safety apparatus can never be thoroughly depended upon, however ingenious its design may be, because the ordinary working of the hoist does not keep the safety apparatus in action; immunity from accidents causes it to be neglected, and when an accident does happen it won't work.

There is nothing so safe as a hoist whose rapid motion is resisted by a considerable amount of friction. But, unfortunately, if the friction is that of solids on one another, there is as much frictional resistance to the ordinary working of the hoist, as there is when an accident occurs, and hence assurance of safety by friction means tremendous loss of power at all times.

Now, you remember that the frictional resistance of water was of quite a different kind. There is almost no resistance to the flow of water, if the flow is slow. There is only a moderate loss of power in the ordinary use of a hydraulic hoist; but the motion cannot become too rapid for safety, for the frictional resistance is exceedingly great at high speeds. A hydraulic hoist, then, can be made perfectly safe without the use of ingenious mechanism.

In a great many hydraulic hoists the action is precisely the same as in Armstrong's cranes. Fig. 15 (p. 989) shows such a construction, used by Armstrong himself. A is a pressure cylinder, with its ram carrying at B the moveable block with sheaves, which pull the chain or wire rope, M, N. There is a loss of effect, due to the altering weight of the chain, as the cage rises or falls. This difficulty may be got rid of by letting the ram move vertically when the altering weight of the ram itself may be made to balance the altering weight of the chain. This has been done in the hoists shown in some of our wall sheets, and all such hoists as this can be readily balanced, so that the dead weights may balance at all points in the ascent and descent. They are, however, subject to the risks inseparable from the use of chains or ropes, and must be regarded as unsatisfactory for this reason. That the lifting of every load means the expenditure of the same amount of energy, is not a consideration of any importance in these hotel hoists. Of course, there is a slightly greater speed when the load is small, as the water pressure is capable of lifting the heaviest probable loads; but you know enough already about water friction to see that the increase of speed is insignificant. This condition is the same for all hydraulic hoists hitherto constructed. In Fig. 12 (p. 988) we see a direct acting hoist. Here the ram moves, pushing the cage up directly. When the pressure of water is very considerable, say 200 lbs. per square inch, and the lift is not too high, this form of hoist is good, for although rather wasteful of power, it is exceedingly simple. The press is sunk so far beneath the floor that there is room for the whole length of the ram when the cage is in its lowest position.

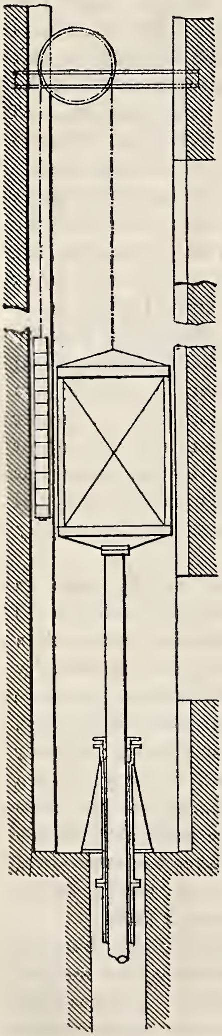
But you must remember that as the cage rises, the supply water pressure ought to get greater. This may be looked upon in two lights. You may either say to yourself, "As a stone is lighter when surrounded by water, so this ram is lighter when it is at the bottom, for more of it is surrounded by water in the press;" or you may put it in this form, "The pressure on the bottom of the ram must just balance the weight of ram, cage, &c., but as the bottom of the ram rises, this means that we ought to have a constant pressure at the bottom of the ram wherever it may be, and consequently a gradually increasing pressure in the cylinder everywhere as the ram rises." Now, I don't care which of these two views you take, but you must not mix them, and say that "not only does the ram get heavier, but it needs a greater pressure at its lower end as its lower end rises." This would be the same sort of thing as saying, "John was lent by James a sixpence; James lent John sixpence; therefore, somehow or other, a shilling has to be paid by John to James." I prefer always to say—"The ram appears to get heavier just in proportion to the amount it has been raised, and this must be balanced by increasing the pressure of the supply water."

Now, remember that our supply water in Fig. 12 is at a constant pressure, and you will see that it is quite impossible, with such a simple arrangement, to have perfect uniformity of action, although it is approximated to more and more nearly as the pressure is greater. In this kind of hoist it is usual to let the water escape from the cylinder to a discharge cistern considerably above the cylinder, so that in its descent the ram and cage may not fall too rapidly. Here, again, we have the same want of uniformity of action, since the apparent weight of the ram gets less as it falls.

The usual practice has been to nearly balance the dead weight of ram and cage by a weight, as in Fig. 11 (p. 988), so as not to require too high a lift in the discharge-pipe, and to so arrange that the varying weight of chain shall just balance the apparent change of the ram. Unfortunately, these chains and counterweights destroy the simplicity and absolute safety of the hydraulic hoist. If the ram were to break near its upper end, the cage would be drawn violently upward by the chain. The upper part of the ram is in tension, and the lower part in compression.

It is obvious, then, that there must, for a complete and perfect hydraulic lift, be such a regulation of the pressure of the water as it enters the cylinder of a hoist, that the only force to be overcome shall be the variable weight placed in the cage, whether that of passengers or goods, together with the necessary friction. I think that Mr. Ellington's Balance Hoist satisfies this condition. It can be worked with either high or low pressure water; the ram is always in compression, supporting the load, and no part of the machinery is above the cage, and there is no part of the machinery likely to break in such a way as to cause an accident.

Fig. 11.



This hydraulic balance lift is shown in Figs. 13 and 14 (p. 989). The hydraulic cylinder, ram, and cage are as usually made, except that the ram is somewhat smaller in diameter. Its size is determined by the strength required to carry the load, and not by the working pressure of water available. The lift cylinder is in hydraulic connection with a second and shorter cylinder, below which is a cylinder of larger diameter. There is a piston in each, connected by the rod. The capacity of the annular space, E, below the upper piston is equal to the displacement of the lift ram. The annular area of the lower piston is sufficient, when subject to the working pressure, to overcome friction and lift the net load; and the full area of the upper piston is sufficient, when subjected to the same pressure, to

Fig. 12.

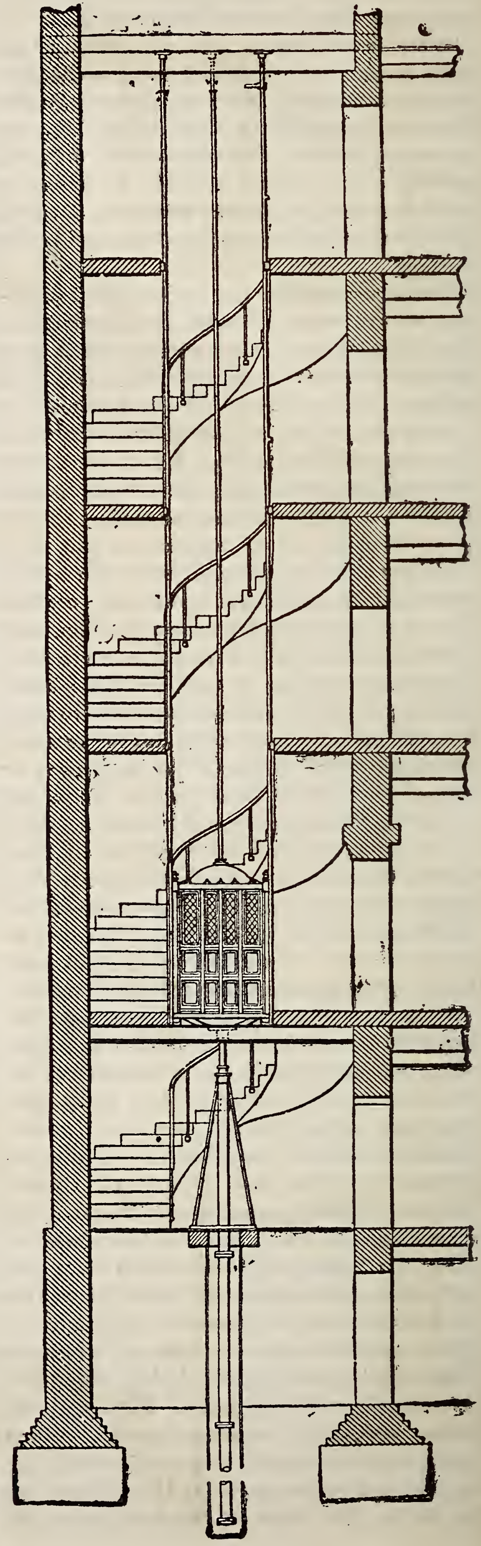


Fig. 13.

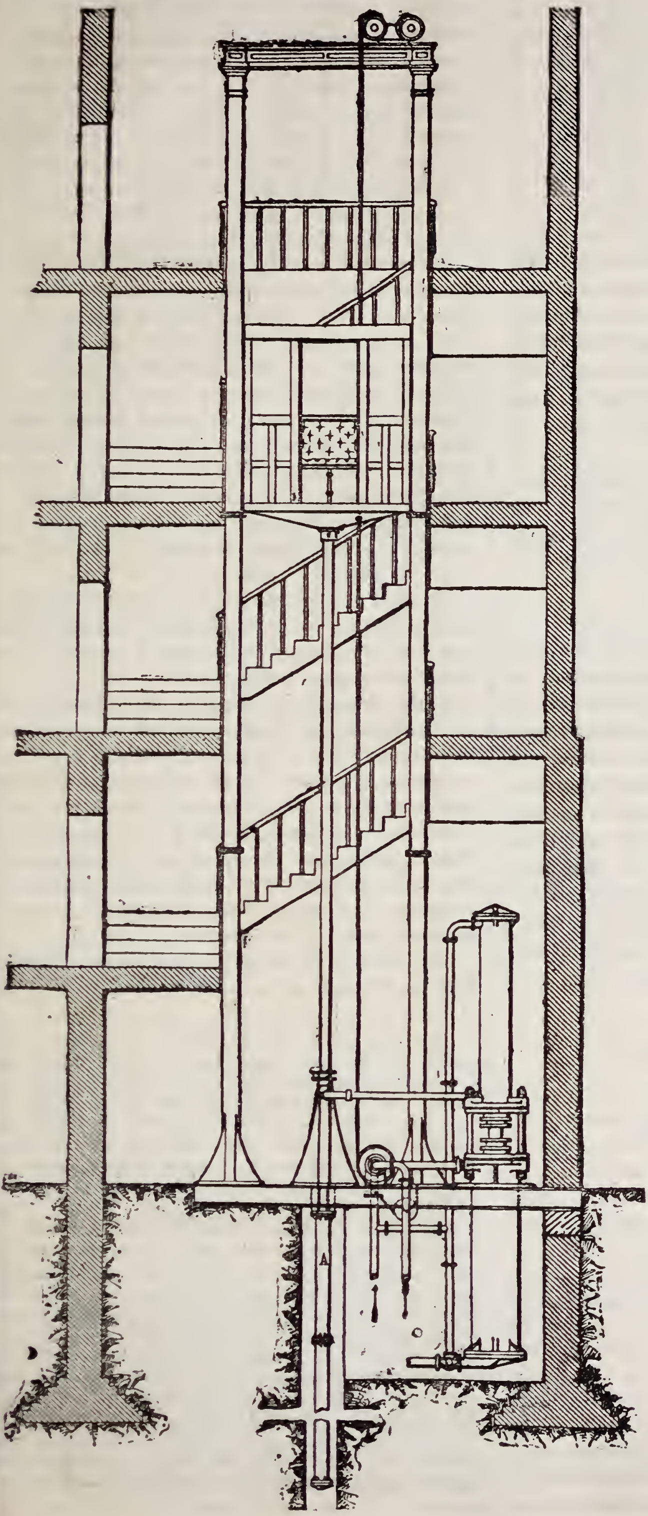


Fig. 14.

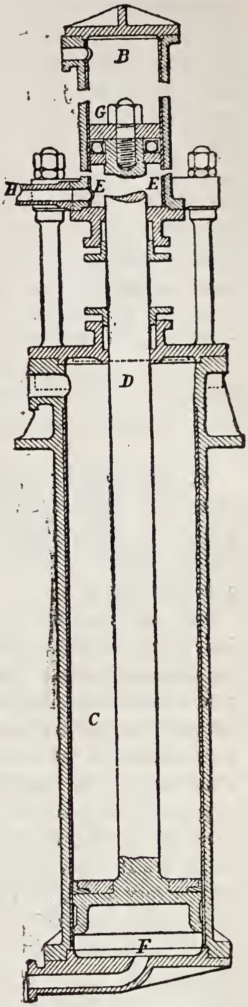
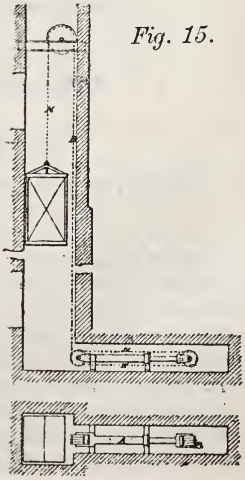


Fig. 15.



balance within a small amount the unalterable weight of the ram and cage.

Assuming the cage at the bottom of its stroke, the valve is opened by a man in the cage pulling on a rope, by a system of levers, and pressure water is admitted. The pressures on the two pistons cause them to descend, forcing water from the annular space to the hoist cylinder. The hoist ram ascends, and in doing so gets heavier, but the pistons are descending, and the total pressure on them is getting greater just in the same proportion. When the ram reaches the top of its stroke the valve is closed and the lift stops. Now, open the exhaust valve, which lets the water pass away from C, only from C, remember, and the weight of the ram and cage presses the water from the lift press into E, causing the pistons to rise.

To make good any possible leakage, provision is made for admitting pressure water under F, and so raising it, the lift ram being at the bottom of its stroke, that water will flow into the space.

We see that the hydraulic hoist has—1st. The great element of safety from the breakage of chains or ropes. But, in some forms, it is not without a danger of its own—namely, the danger that when the cage is remaining caught in a fixed elevated position for a time, the cylinder may be emptying of water through a neglect of the valves. 2nd. That the expenditure of energy depends very little upon the dead load. But there is still the drawback that every load, however small, requires the same expenditure of energy as the greatest load which the hoist can lift. This drawback is common to all hydraulic hoists such as I have been describing.

Miscellaneous.

NOTES ON RHEA OR RAMIE FIBRE.

By P. L. Simmonds.

Nine years ago, I drew attention in the *Journal* (vol. xxi., p. 760) to the Rhea fibre. Rhea is the Assamese name; now, however, the fibre is more generally known and spoken of in Europe as Ramie (the Malay name), though still in commercial circles here, and among brokers, passing under the singularly inappropriate name of "China grass." And here I cannot but agree in the remarks of my friend, Baron Sir Ferdinand Von Mueller, the eminent botanist, of Victoria, that we may hope to see the highly unsuitable names of gum trees, she oaks, native cherry trees, rib grass, New Zealand flax, rice-paper plant, and other ridiculous names discarded in favour of the unmistakable and logically-correct applications which science has for all of these, and which are easily enough retained in the memory. The London brokers have, indeed, lately converted New Zealand flax into New Zealand hemp.

It may be useful to some to give a *résumé* of what has been done in the matter of rhea fibre, its cultivation and preparation for market, in the last ten years.*

The present imports of this fibre, chiefly from Shanghai and Canton, are only about 100 to 150 tons per annum; the price has ranged from £26 to £120 per ton, but £50 or £60 may be considered the medium. The cost of freight is now £8 to £10. It is difficult to arrive at the total quantity produced in China, for it passes under the general name of hemp, and appears to be grown in Formosa, and the provinces of Kwangtung, Honan, Chehkiang, Hupet, and Manchouria. It seems to range in price there according to quality, from 8 dollars the coarse for sail-cloth and cordage, to 22 dollars the fine for grass-cloth, per picul of 133 lbs.

The fibre produced from plants grown in Europe, Egypt, Algeria, and America cannot compare with that from Northern China, being weaker and very deficient in general qualities.

In the Kwangtung, Kwangsi, and Kiangsi provinces are found the principal seats of the grass cloth manufacture, with Canton, Swatow, and Kiukiang as ports of shipment. There are many varieties and qualities, costing from 8 cents to 1¼ dollars per yard. The coarser kinds are exported in small quantities to Manila and Singapore, where, as in China proper, they are extensively used as materials for summer clothing. The finer qualities, embroidered with silk, are much prized by Europeans.

The fibre of *Cannabis sinensis* and *Dolichos bulbosus* is also used for some kinds of grass cloth.

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*In my former paper, I gave a reference to some articles and works, which treated of rhea fibre; and I may supplement this by the following list, which may be useful for reference to those practically interested in the growth and preparation of the fibre:—"The Fibre Plants of India," by J. H. Dickson, London, W. Macintosh, 1865; "Examin. Microscopique des Fibres Textiles," par Dr. Schlesinger. Paris, Reinwald and Co., 1875; "Etudes des Fibres Végétales Textiles," par M. Vitillart. Paris, Firman Didot, 1876; "Select Extra Tropical Plants," by Baron Ferdinand Von Müller. Sydney, T. Richards, 1881; "Ramie," by Emile Lefranc, in Report of American Department of Agriculture, for 1878; M. Dudouy on Ramie, "Comptes Rendus des Travaux de la Société des Agriculteurs de France," 1872, p. 373; an article by Comte de Malartie, in the *Journal d'Agriculture Pratique*, Dec., 1871; "China Grass," Report of American Commissioner of Agriculture, Washington, 1867; "China Grass, Cultivation of," by J. R. Dodge, Report for 1865, p. 347, p. 220; "La Ramie," par Théophile Moerman-Laubuhr, Gand, 1871; "Description et Culture de l'Ortie de la Chine," par Ramon de la Sagra, Paris; Mr. King, in *Journal of the Agricultural and Horticultural Society of India*, vol. 1, part 4.

They are all classed in Chinese under the generic term *Ma*.

The Chinese fibre is well known to be lustrous, tough, and durable; it is suitable for being converted into fabrics which approach in strength those of flax, and in glossiness those of silk, as Oriental ingenuity has long since shown. With us it has sometimes been used to mix with silk fabrics, but dyes do not take well on the combined fibres.

Throughout Japan and India it is very largely used for ropes and cordage, which are twice, if not thrice, as strong as those of hemp. The fibre bast consists of coarse outer layers and finer inner strata. If it could be obtained in quantity, and at a moderate price—say, not exceeding £50 a ton—it could be extensively employed by our manufacturers.

It is doubtful whether the rhea and ramie fibres of India are not really the produce of the allied species, *Boehmeria tenaccissima*, much coarser and stronger than the fine, lustrous, long-stapled fibre that is shipped from Northern China.

In view of its fineness, strength, and beauty, ramie will yet command an exercise of European ingenuity, which will make its culture a profitable industry.

France has been stimulating the cultivation of the plant in many quarters. The Society of Acclimatisation of Paris, at its recent annual meeting, awarded no less than five silver medals to the following cultivators:—Comte Abbadie de Barrau, in the department of Gers; M. de Latour, in that of Gironde; M. Jules Bertin, Maison Lafitte, near Paris; M. Ch. Riviere, in the province of Alger; M. Joseph Tramier, in the department of Vaucluse.

From some experiments made in Java, upon stems grown in the botanical gardens of Buitenzong, it would seem that the wood forms about 70 per cent. of the weight of the stem, and, perhaps, with the moisture, 77 per cent. A chemical bath, of which the ingredients are not stated, deprived the filaments of the parenchyma and the mucilaginous matters, and cottonised them. The textile filaments yielded were under 2½ per cent., and of this, ·15 being epidermis, it results that the stems yielded only about 2 per cent. of fibre, which is much less than that obtained from flax and hemp, but sufficient yield to pay expenses. Three cuttings a year were obtained.

This fibre admits of no retting action on the stalks; steeped and fermented in water, or exposed to the air, it is decomposed, or reduced to a short and weak fibre, saturated with tannic acid, and spotted with tan bark. The fibre can only be obtained by separating first the injurious outer bark, and this being removed from it, by the ordinary process of retting and bleaching, on the uncoated and free filament. The Chinese skin the stalk, and clean the outer bark of with a knife, and each man produces, in this manner, from one to two pounds per day of raw product.

The best mode of bleaching is said to be that of Bertholet. It consists in first steeping the fibre or vegetable tissues in boiling water, and then rinsing them in a copious supply of water, in order to disengage them from soluble matter. When the water has entirely dropped off, they are plunged into a bath of alkaline lye, which is raised to the boiling-point; they are then immersed in a solution of hypochlorite of lime or another alkaline hypochlorite. The tissues are washed in a copious supply of water, afterwards immersed in water acidulated with sulphuric acid, washed with soap and water, then rinsed in water and dried.

The attempts which have hitherto been made to discharge the gum renders the samples of fibre tender, rotten, of bad colour, and lustreless. No reliable machine for stripping the fibre and taking off the outer part has yet been put in operation. Such a machine would do much towards placing this plant among the permanent and valuable products of agricultural industry.

The primary conditions which a machine for the purpose has to fulfil are, first, that it would be so cheap that it would be within the reach of the bulk of the cultivators of this country; second, it must be so easily worked that ryots of ordinary intelligence in India should be able to use it; and third, it must be so simple that any village blacksmith should be able to put in order when required. Such a machine would effect a radical change for the better, in the present rude and defective mode of separating the fibre.

Practical persons, familiar with the treatment of textiles, know the impossibility of cleaning thoroughly any fibre, dried or green, by the continuous action of machinery. Either with drums or beaters, the cleaning instruments cannot turn out the filament without a certain quantum of chaff and other refuse entangled in the fibre. All experiments on this point have failed, and proved the insuperable difficulty of expelling by continuous friction, all the particles of pith that have penetrated into the fibre. It is only through a scraping process, acting in a backward and forward direction, that a perfect cleaning can be obtained.

Ramie is a most exhaustive crop for the land, and requires much manuring, and the yield of fibre is comparatively small, compared with other plants. It can only be obtained in small quantities at present, and we can merely expect supplies from such a country as China, where labour is cheap and population dense.

In 1871, the Government of India offered a reward of £5,000 for the invention of a good machine, but only one was produced in response, by Mr. John Greig, of Edinburgh, which did not meet the requirements, but received a bonus of £1,500. Although the machine worked well, and was much superior to hand labour, it was too slow, in consequence of its cleaning only one half of the stems at a time, necessitating, indeed, five distinct operations. The stems had to be put into the machine, taken out, the ends reversed by hand, and again put in, and finally taken out before they were thoroughly cleaned. This machine has not since been adapted by the inventor to practical use.

In 1873, M. Emile Lefranc, of New Orleans, patented an improved decorticating machine, which he asserts removes the fibre from its tenacious bark and pithy envelope. The machine is figured and described in the Report of the American Commissioner of Agriculture, for 1874, Washington.

In 1874, M. Felix Roland, of Paris, invented a machine for decorticating the ramie plant by separating the fibre from the bark and the bark from the stalk. It is described as simple and moderate. It is designed, not only for the treatment of ramie, but of other textile plants of which the fibres are utilised for the fabrication of tissues. The stems can be worked by it either green or dry, and whether retted or not, but it does not thoroughly separate the fibre from the stem.

In 1879, M. A. Favier, of Nimes, invented a process for operating on the dry fibre, removing it perfectly and entirely from the woody stem, at a cost of only about £4 per ton. He forwarded me samples of the fibre as it issued from his machine, without combing or unginning, and yet perfectly fit for spinning. He had not been able to obtain green stems to operate upon.

A committee was appointed in India, in Sept., 1879, to conduct the experiments for the renewed prizes offered by the Indian Government for the best machine or process for the separation of the bark from the stem, and the fibre from the bark. There were twenty-four applications to compete, but the results of the experiments at Saharanpore were not satisfactory, although some progress was shown.

In May, 1871, a cleaning-machine was patented in America, by Mr. Adolph Blanchard, of New Orleans.

Dr. R. Collyer, who has long given his attention to fibres, has invented a machine which he alleges will operate most effectively on one and a-half tons of rhea stems per hour, and extract from the same 210 lbs. of clean marketable fibre, worth at a minimum £35 the ton; the total cost of every kind he states to be but £10 per ton. He first boils the whole stems with soap water.

Mr. S. C. Lister, of Manningham Mill, Bradford, commenting on my paper (*Journal*, vol. xxi., p. 841) in 1873, spoke favourably of the fibre - cleaning machine of Sandford and Mallory as useful for the purpose.

Messrs. van Maanen and Moorrels of Satatiga, Java, reported, early in 1880, that after many years of experiments, at heavy expense, they could not fully attain the desired object of separating from the green stem the fibres in a clean and white condition, free from gummy and woody constituent parts. They could, indeed, approach it by stamping and beating, for a long time, the fibres separated by machinery; but with an eye to the market price, too much hand labour was required. Even chemically they could not succeed in removing from the bark the viscid matter, which soon becomes hard, without doing damage to the strength of the fibre. The separation of fibre from the dry stem they found to be easier and more profitable. The only objections to the dry method, are that the resulting fibre is not completely white, and that artificial drying and bleaching would be required during the greater part of the year.

The offer of the Indian Government has brought out many competitors, and various descriptions and qualities of machines were invented, but none has yet thoroughly answered the object in view. The repeated efforts made are, however, steps in the right direction.

The Cosmos Fibre Company, of Dusseldorf, invented in 1881 a machine said to be capable of perfectly cleansing the bark of all resinous and woody matter.

The Acclimatisation Society of France has recently granted the large gold medal, placed at its disposal by the Minister of Agriculture, to M. Berthel, for an improved machine which strips and prepares the ramie fibre on the spot in the green state, and also operates successfully on other textiles, as agave, jute, &c. I have not met, however, with any description of the machine.

The Jamaica Institute has offered this year a prize of £50 for one cwt. of clean marketable fibre, produced by machinery, in the island from rhea, pinguin aloe, or fourcroya. A preference will be given to such samples, as are produced without chemical maceration, and are proved by brokers' reports to be suitable for and acceptable in the English and American markets.

TORPEDO-BOATS.

At the meeting of the British Association, Mr. Donaldson, one of the partners of the firm of Thorneycroft and Co., read a paper on this subject, of which the following is an abstract :—

After some remarks on the importance of the torpedo-boat as an engine of warfare, Mr. Donaldson described, in detail, with the aid of models and diagrams, the two distinct groups into which the various types of torpedo-boats have gradually been resolved, viz., those attached to and carried by larger vessels, to which they would act as auxiliaries; and those sufficiently large to act independently, and, to a certain extent, to keep the sea, which would be used for harbour and coast defence. These two groups have been named, by the English Admiralty, the first and second-class groups, respectively.

The dimensions of the present English second-class boats are :—Length, over all, 63 ft.; beam, 7 ft. 6 in.; draught of water, 3 ft. 4 in.; displacement, $12\frac{1}{2}$ tons. The hull is constructed of Bessemer steel, galvanised, and is divided into ten compartments by means of bulkheads and half-bulkheads. The machinery consists of a pair of compound surface-condensing engines, having cylinders $8\frac{1}{4}$ in. and 13 in. diameter respectively, by 8 in. stroke; giving 150 indicated horse - power at a speed of 653 revolutions per minute, corresponding to 17·65 knots per hour; the maximum measured-mile speed attained by these boats. The surface condenser is of copper, tinned inside, and the condensing water is supplied by means of a centrifugal pump 8 in. diameter, driven by a separate engine. The boiler is of the locomotive type, the shell being made of steel with a copper fire-box and brass tubes, strong enough to withstand a water-pressure of 260 lbs., and a working-pressure of 130 lbs. per sq. in. The area of the fire-grate is 6·6 sq. ft., and the heating surface 268 sq. ft. The stokehold is entirely enclosed, and the air is supplied to the boiler by means of a fan, driven by an independent engine, which at a speed of 800 revolutions per minute give a pressure of from 2 to 3 in. of water. The stokers are kept cool and comfortable by the large volume of air passing through, and to provide for their safety the fire-door of the boiler is made to shut tight; the ash-pan is cased in with a light casing, having flaps in front opening inwards, which would close on any undue pressure; such as would arise from the bursting of a tube or other sudden leakage in the boiler, and an escape, closed at normal pressure by a door fastened by a spring, is carried up to the deck. By means of a nozzle fitted into the bottom part of the barrel of the boiler, and a pipe carried to the deck, the boiler of the boat can be connected with the ship's boiler, and a steam-pressure of 60 lbs. raised in about 9½ minutes, by which time the fan, also driven by the borrowed steam, has brought the fire into condition to maintain that pressure.

These boats are fitted with an ejector in the stokehold, capable of ejecting 45 tons of water per hour. The centrifugal pump can be utilised for emptying the bilges, and the two together would eject the whole displacement of the boats every 10 minutes. The lifting weight of the boats all on board is 12½ tons, and the lifting is effected by means of slings, attached to hoops on the bulkheads forward of the boiler-room, and aft of the engine-room.

The second-class boats, built or building by the author's firm for the Danish and Italian Governments, are substantially the same as the English second-class in hull, engines and boilers, but in the Danish boats the pumping is done by ejectors alone, six of which are fitted in different parts of the boat, and are capable of ejecting the whole displacement every 5¾ minutes. The ease and readiness with which an ejector can be turned on in any compartment, without the necessity of communicating with the engine-room, is a strong recommendation in favour of that method of pumping. All second-class boats now carry two 14 in. Whitehead torpedoes, and the Danish and Italian also carry two-barrelled Gardner machine guns.

There are three methods of ejecting the torpedoes. The earlier English boats are fitted with davits and discharging frames, so arranged that the frames can be lowered over the side, close to the boat and parallel to its centre line, to a depth of 2 ft. under the surface of the water. In this system no external impulse is used; the pulling of a lanyard liberates the torpedo and starts its engine.

This system has been superseded in the later English boats, in which the torpedoes are laid all ready for discharging in two troughs on the forward part of the deck, and are projected therefrom by means of two pistons and rods, working in steam cylinders 4¾ in. diameter, by 7 ft. stroke. This system has given excellent results in experiments at Portsmouth.

In the later Danish and Italian boats, the troughs have been replaced by tubes from which the torpedoes are ejected by compressed air stored in reservoirs, and admitted into the tubes behind the torpedoes, Besides other advantages possessed by the air-impulse system, so long as the reservoirs and torpedoes are charged, the boat may be used independently of steam being up in the boiler, and would thus serve as so many launching tubes on the ships to which they are attached.

Coming to the first-class boats, these, in general construction, hull, engines, and boilers, resemble the second-class type, but are, of course, on a larger scale.

The dimensions of most of the Admiralty first-class boats are:—Length over all, 87 ft.; beam, 10 ft. 10 in.; draught of water, 5 ft. 2 in., with a displacement of 32·4 tons. That, however, represented by the model was 90 ft. 6 in. over all, by 10 ft. 10 in. beam, and, like the rest, was fitted with engines, having cylinders 12¾ and 20⅞ in. respectively in diameter, by 12 in. stroke, which, on trial, gave indicated horse-power 469, at 443 revolutions per minute, and speed, 21¾ knots per hour.

The Italian type of first-class boat is 100 ft. long, 11 ft. 8 in. beam, and has a draught of water of 5 ft. 5 in., and 34·5 tons displacement. The cylinders are also somewhat larger, being 13½ and 22 in. diameter respectively; the boilers are also larger, having a grate surface of 19·4 sq. ft., and a heating surface of 698·8 sq. ft.

The sub-division of the hulls by bulkheads and half-bulkheads is similar to that in the second-class boats, and ejectors are similarly fitted. The six ejectors of the Italian boats are alone capable of pumping out the whole displacement in 7¾ minutes. In the Italian boats all the pumps are driven by a separate engine, and the main engines are devoted entirely to propelling the boat.

The English first-class boat carries three 14 in. Whitehead torpedoes, two in transporting carriages on the sides of the vessel, and one in the torpedo-gun, as it has been called, on the forward deck. By means of this gun, which can be elevated or trained like an ordinary gun, the torpedo may be projected ahead or on either side. Hence there is no necessity for attacking bows on, as in the second-class boats, nor for stopping immediately before or after the discharge. In the earlier examples, the torpedo was ejected by an air-impulse gear; now, a cartridge, containing a slow-burning powder, is used.

The objections to this system are—that the boat carries to the attack only one torpedo ready to be ejected; that the gun cannot be reloaded without retiring, or else exposing the men engaged in the operation to great danger; and the reserve torpedoes are liable to be hit by Nordenfelt bullets or Hotchkiss shell, either of which would certainly disable them, and might even cause a destructive explosion.

The Italian and Danish boats carry four 14 in. Whitehead torpedoes, arranged as in their second-class boats, that is—two in the ejecting tubes, and two in the loading troughs immediately behind, but in this case all are completely enveloped in the hull of the boat. To reach them, a bullet would have to penetrate $\frac{3}{32}$ in. of plating, and $\frac{1}{8}$ in. of tube, in all $\frac{7}{32}$ in. The torpedo is ejected by an air-impulse gear, similar to that already described, the air for which, and for the torpedoes, is supplied at a pressure of 70 atmospheres by a small air-compressing pump in the engine-room.

A permanent lifting gear, similar to that of the second-class boats, has recently been fitted to these boats, and the first two of them, weighing about 28 tons each, were shipped in an hour and a-half.

The largest torpedo-boat built by the author's firm, and the largest yet afloat, is that lately supplied to the Danish Government. She is 110 ft. long by 12 ft. beam, draws 6 ft. 3 in. of water, and has a displacement of $52\frac{1}{2}$ tons. Her speed on the three hours' trial was 20 knots per hour, and she carries coal (10 tons), to steam 1,200 knots at a speed of about 11 knots. Her armament consists of four 15 in. Whitehead torpedoes, 19 ft. in length, and carrying a charge of 80 lbs. of gun-cotton. The Danish Government propose to carry this boat and others of her class from point to point of the coast on their railways, so that an enemy would know nothing of their movements or where to expect them.

A still larger boat is under construction for the Russian Government, she will be 113 ft. long by 12 ft. 6 in. beam, with a displacement of $58\frac{1}{2}$ tons. Her contract speed is the same as that of the Danish boat, but will be obtained under severe conditions, to secure that the trial trip speed shall be maintained on actual service.

Relatively to the Whitehead torpedo, the Spar torpedo must be considered as a torpedo with a spar 10 yards, as compared with one having a spar 400 yards long, that being the range at which the Whitehead torpedo may be considered tolerably effective. Yet the Spar torpedo is not to be looked on as obsolete, and in the hands of a seafaring population, trained to the use of torpedo-boats, it would prove most efficient. In circumstances such as prevailed at the bombardment of Alexandria, when the attacking ships were so enveloped in smoke that the firing had to be suspended, it is a question whether the Spar torpedo would not have been both the most certain and the least hazardous weapon of attack. The English first-class boats are now being armed with the Spar torpedo as an alternative armament.

In conclusion, the author pointed out the importance of a properly-organised torpedo service for coast defence both at home and in our colonies, and particularly for our scattered coasting stations, which, in the exigencies of a great war, might be left a prey to any adventurous captain. A disaster to our navy, or the calls that might be made upon it in a great war, might leave our harbours and navigable rivers temporarily exposed to the attack of an enemy, and although no one would propose that torpedo-boats should take the place of forts and land defences, yet the knowledge of their presence, and the risk of being struck at any moment in his most vulnerable part, would compel an enemy to approach our forts with far greater circumspection than was considered necessary in encountering the heavy guns of the Alexandrian batteries.

THE BLEACHING OF JUTE.

M. Albert Scheurer has lately published, in the *Moniteur des Lils et Tissus*, some details of interest as to his own experience on this subject.

Chloride of lime was at one time considered suitable for jute bleaching, but it was soon found that this reagent made the yarn hard and brittle, likewise removing, along with a portion of its solidity, that silky brightness which constitutes one of its principal merits.

Hypochlorite of soda, on the contrary, by reason of the more rapid and uniform oxidation which takes place, can be employed at a high degree of concentration without the resistance of the fibre being impaired. Its action has, however, to be regulated with care on account of its powerful properties as a reagent. Bleached jute would suffer by being plunged into a concentrated solution of hypochlorite of soda, while such is not the case with jute in the unbleached state, in which the cellulose is protected in the earlier stages of the operation by the incrusting substance. It is the latter portion of the process (specially affecting the purification of the white) which is usually found to affect the solidity of the textile substance under treatment, even when the solution has not been a strong one.

Therefore, M. Scheurer considers that, to save the fibre from the corrosive action of the hypochlorite, it is necessary to diminish the force of the reagent, as the operations succeed each other, and to preserve a certain relation between the degree of concentration of the oxidising liquid, and the quantity of the incrusting substance which remains to be destroyed. In this way a satisfactory white is obtained, without prejudice to the textile substance operated upon.

M. Scheurer's remarks are suggested by an interesting report made by M. Witt to the Industrial Society of Mulhouse. This report deals with the invention of Mr. Cross, which has been adopted by the Barrow Flax and Jute Company, for the purpose of improving the bleaching of jute, the merits of which, it will be noticed, are fully recognised in the remarks quoted.

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Proceedings of the Society.

CANTOR LECTURES.

HYDRAULIC MACHINERY.

By Professor Perry.

Lecture IV.—Delivered March 27th, 1882.*

You can now have no difficulty in understanding the construction of all warehouse and hotel lifts. The hydraulic principles involved in all lifts are the same, but with larger weights to be raised there are peculiarities of construction which require attention. It is, however, no part of my object to discuss structural details.

In Figs. 1 and 2 (pp. 996 and 997), we have two similar lifts erected at the Seacombe-pier, on the Mersey, to take carts and wagons from the floating landing stage to the high level. The height of lift is 32 feet, and the net load 20 tons. Here you have simply direct acting rams and presses sunk in the river-bed, the presses being surrounded by cast-iron protecting cylinders. In this case there has been no attempt to balance the increasing weight, that is, the displacement of the ram as it rises. Each cage, or platform, is supported on one ram, and the designer had to take care that the weight of any wagon should be so carried on the top of the ram that no part of the structure was unduly strained. The wagon rests on a platform, which can slide on the bottom of the cage, so that although the cage rises vertically, the platform may everywhere be in the position in which it would be on the landing-stage, if the landing-stage rose and fell. The landing-stage is attached, as you know, by girders, which do not alter in length, so that it does not rise and fall vertically, but really in arcs of circles. In this case, the lift is of a variable amount, depending on the height of the tide. There is a connecting valve between the two presses so that a descending load in one lift may raise a less load in the other when necessary.

This idea of having two lifts side by side, so that the lowering of one may cause the rise of the other, you will understand better in the original example of its use, the canal lift of Messrs. Clark and Standfield on the River Weaver, in Cheshire. Fig. 3 (p. 998) shows the canal and the river, one 50 feet above the other. We want to raise or lower canal boats from the one to the other, and we want to avoid the expenditure of water, and the delay which occurs when there is a chain of locks.

Here are two great wrought-iron troughs, each 75 feet long, and 15½ feet wide, each being carried on the top of a ram 3 feet in diameter. Now when I tell you this, you will at once see how incomplete my description is. Each tremendous trough is carried easily by one ram acting at its centre. You can, in your imagination, go into all the details of girder-work necessary for the safe carrying of such a load in such a manner. The weight of each trough, with the water and barges in it, is 240 tons, and this gives a pressure of about one quarter of a ton per square inch in the press. At each end of each trough there is a gate.

When the trough is up, and gate A is lifted, the trough forms part of the aqueduct. A barge floats into it from the canal, and the gate is closed again; also the aqueduct end is itself closed with a gate. Now the trough is lowered containing the barge, and when it reaches the lower level, gate B is lifted, when, of course, the trough really forms part of the river. You must describe to yourselves how this press is sunk—how we have here a tunnel which enables us to examine the packing of the cylinders, how these great columns are firmly supported, so that we may have guides to prevent the tilting of the troughs. All this is constructive detail which you can read about in the Proceedings of the Institution of Civil Engineers. You might fear also that the joints of the gates at the end of the trough might be leaky, and above all, that the joint of the trough with the aqueduct end might be leaky, but even from the diagram you can see how perfectly these difficulties can be got over.

Suppose I have a boat in any vessel of water, and I know that the water is at a certain level, and I take out this boat and put in another boat, and add water or take it away until the level is just what it was before. You know that the weight of boat and water is always the same. The total weight simply depends on the level of the water. The weight of the boat alone is always equal to that of the water it displaces, and, therefore, this vessel filled to this height with water, if there is no boat, will just weigh the same if there is a boat in it and the water is at the same level as before.

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* It should be stated that the blocks for Figs. 2, 3, 7, 9, 10, and 18 in Lecture I., lent, as acknowledged in the *Journal* for the 1st inst., by Messrs. Cassell, Petter & Galpin, were specially prepared for Professor Perry's forthcoming book on "Practical Mechanics."

Now, suppose that this trough, M, is part of the canal, and there is or is not a barge in it, and suppose that N is down, and is in communication with the river, and there is or is not a barge in it. Now close the gates. Suppose there is five feet of water in M, and that, if there is not four feet six inches of water in N, we let water into or out of it from the river till the water is at this level. Now let this valve be opened; it is evident that water will flow from one press to the other, for M is heavier than N, and M will fall, causing N to rise. Suppose the lifts were very high indeed, it is evident that this falling will not stop till M is well below the level of N, in fact, till the lightening of the ram M, as it displaces more water, and the increased weight of ram N as it leaves the water in its press, till these two added together are equal to the real difference in the loads of M and N. In the present case, the lift is not great enough for such an effect to occur. But as soon as M enters the river it gets very much lighter in weight. Indeed, as soon as it sinks six inches into the river, the weights of M and N are equal, so that leaving out of account the displacements of the rams, N cannot be raised any further by the falling of M. There is exact balance, and no further motion, then when N and M have still more than four feet six inches further to travel. The valve is now closed; there is no further communication between the presses. The press of N is put in communication with an accumulator, which lifts N, pressing it home at its water-tight joint with the aqueduct. The water in N is six inches lower in level than it ought to be however. Water is allowed to pass from the aqueduct through a valve into the space between the two gates G¹ and G, when G¹ is easily lifted; G is also easily lifted now, and water passes freely into N, as it is now part of the aqueduct, and the barges can be taken

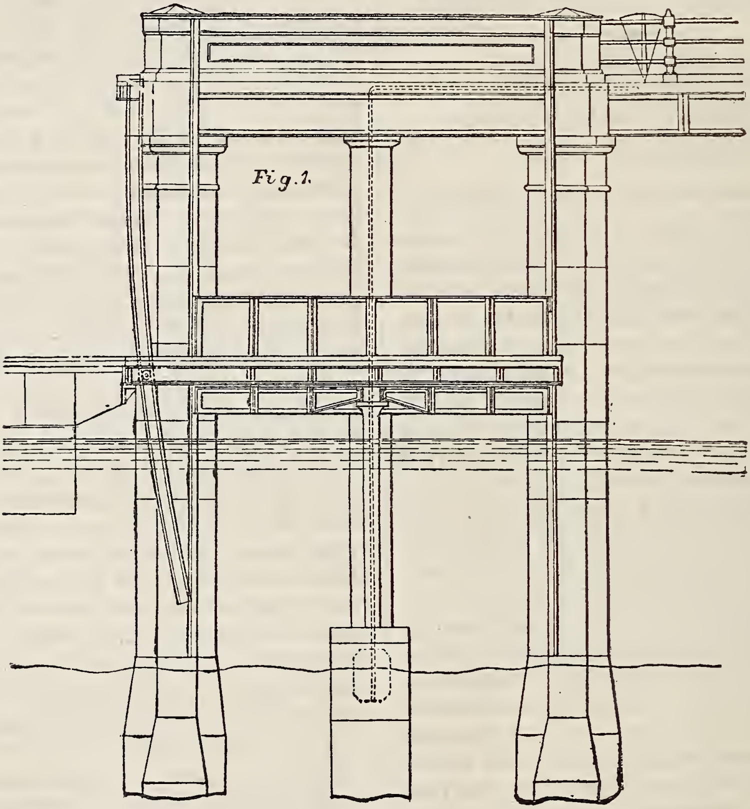


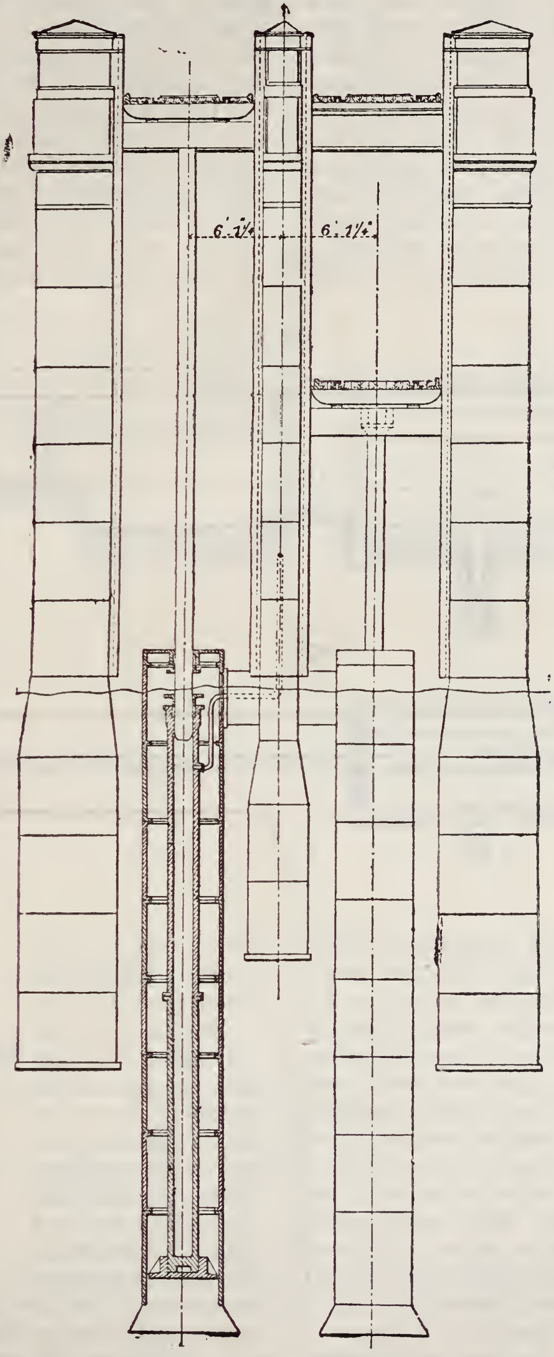
Fig. 1.

off into the canal. Meanwhile we have left M still resting in great part on its ram. The water from its press is now allowed to escape, and M sinks in the river, its river-gate is lifted, and the barge is taken out.

Twelve siphons in M were put in working order during its immersion, and when it is being lifted again they empty it down to the level of their free ends, which are adjusted to leave exactly four feet six inches of water in M. Thus there is an automatic adjustment of the water-levels in M and N, so that whatever be the weights of the floating barges they contain, the total weight is always the same for every operation.

The waste in an operation comprises first, six inches depth of water in one of the troughs. The falling of this 50 feet is 1,800,000 foot-pounds. Secondly, the accumulator raises N, 4 feet 6 inches, and as the weight of N is about 240 tons, the waste here is 2,419,200 foot-pounds. The total waste is then about 4,219,200 foot-pounds.

Fig. 2.

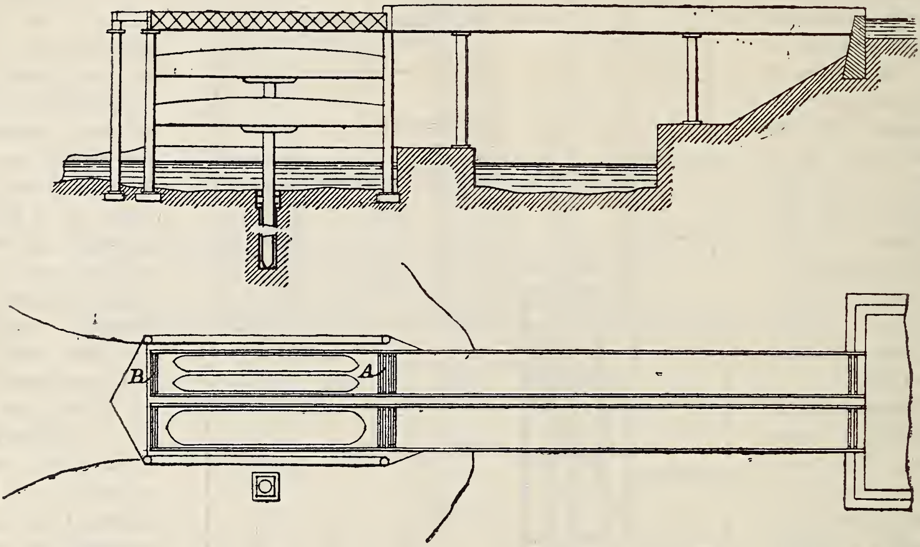


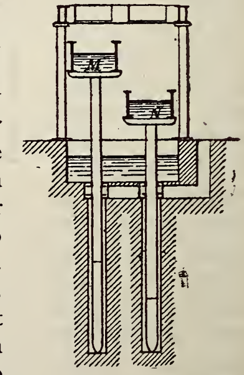
Now, suppose the same operation were performed down a flight of ordinary canal locks, under favourable circumstances they would require that 14½ feet depth of water of the area of one lock should fall 50 feet, or there would be an expenditure of 51,500,000 foot-pounds, or twelve times as much as with this lift. If, however, a canal has a plentiful supply of water, this is not of such great importance as it seems. It becomes of great importance, when, as in the present case, there is but a small supply of water. The advantage of the use of such a system as the present is rather, in my opinion, in the fact that the operation is finished in eight minutes, whereas in a similar ascent or descent, but by means of a flight of locks, at Runcorn, the operation of letting one barge through requires one hour and a-half. Anyone who has come through the Caledonian Canal, will sympathise with Messrs. Clark and Standfield in their efforts to diminish the waste of time involved in passing a flight of locks.

We are, however, more interested, just now, in the hydraulic question, the saving of energy, the saving of water from the canal, and accumulator energy, and so I take you to consider a somewhat similar canal lift shown in another wall-diagram, which has been constructed by the same firm at Fontinette, near Belgium, to replace a flight of 5 locks, with a total fall of 43 feet. The troughs are of double the length, and are of greater depth than the last. Each ram is 6 feet 6 inches in diameter, but there is the improvement that we have what are called compensating reservoirs. Water flows from one of them to the descending trough, thus increasing the weight of it, just in proportion as its ram becomes immersed in its press; and water flows back again from the ascending trough to the reservoir, just in proportion as its ram comes out of its press. Thus the ram displacement is balanced. But there is a further improvement: the descending trough does not descend into water, for this made it get light too soon; it descends into the dry chamber, and only becomes a portion of the lower canal when the gates are lifted. Thus the falling of one trough can lift the other all the way to the upper level, and the accumulator is only needed to supply leakage from the presses. A single operation causes a loss of 20 tons of water from the upper level, or less than 2,000,000 foot-pounds altogether. You must remember that the troughs have more than twice the capacity of those at Anderton.

We have noticed here one of the methods adopted by this firm for balancing the change due to displacement of rams. But they have adopted many other methods to suit special cases, in which the falling of an accumulator ram causes the rise of another ram. Thus, for example, they let a ram rise vertically above the accumulator, passing water-tight into a tank of water. Its increased weight, as the accumulator ram descends, compensates for the displacement effects of all the other rams in the arrangement. Again, they have a tank of water as part of the load of the accumulator, and its water level is kept the same as that of a neighbouring fixed tank, by means of a syphon, so that the weight increases as the accumulator ram sinks. By properly shaping this tank, they are able to get any variation of pressure that is wanted during an operation, for such purposes as cotton pressing, &c. It is easy to see that we have here a means of balancing accurately the dead weight of any platform and its ram, which has to be raised and lowered, at every point during an operation, by the use of an ordinary accumulator.

Fig. 3.

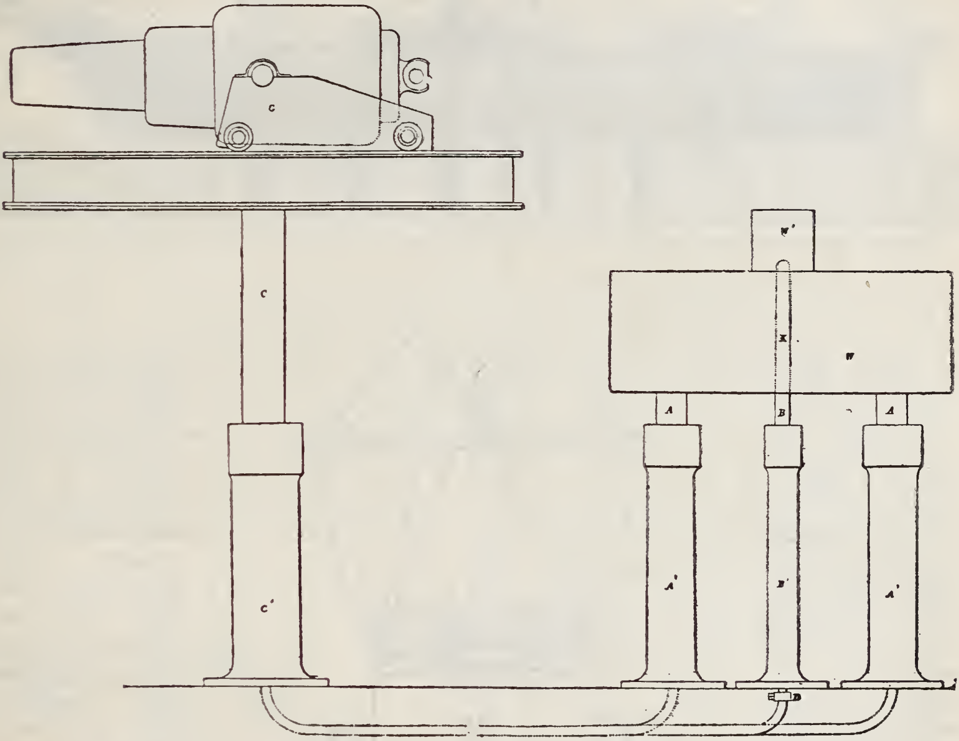




It remains to show how the extra energy is obtained for the lifting of loads on such a platform; that is, for lifting a load, and also for overcoming friction.

Here is a gun (Fig. 4, p. 999). I shall not speak of the press which gives power to make the gun traverse. We will only speak of the lowering and raising of the gun. Its platform rises and falls on this ram, C, which works in the press, C′. The accumulator consists of two large rams, A A, and a much smaller ram, B. These three rams rise and fall together, and carry the accumulator load, but you see that they have separate cylinders. Now if B′ merely communicates with a low neighbouring cistern, whereas the presses, A′ A′, form the accumulator for the gun press, the pressure in A′ A′, and consequently in the gun press, is great enough to lift the gun. Remember that the load, W, owes very little of its support to the ram, B, and it is great enough when acting on A A alone to overbalance the gun. Now let B no longer open into a low pressure cistern, let it communicate with the other presses. The weight, W, is supported by more plunger area, and consequently it is lifted, the gun sinking. In fact, whenever B^1 is disconnected from the rest, the gun rises; whenever B^1 is connected with the rest, the gun sinks. As water goes into the cistern every time the plunger, B, sinks, we must supply, by means of a little steam-engine, or in some other way, such an amount of pressure water as will enable the accumulator to lift the gun to its proper position every time. In fact, water has to be pumped into this accumulator by a force-pump, just as with any other accumulator; but you will observe that we lose in each operation only a small quantity of pressure water.

Fig. 4.

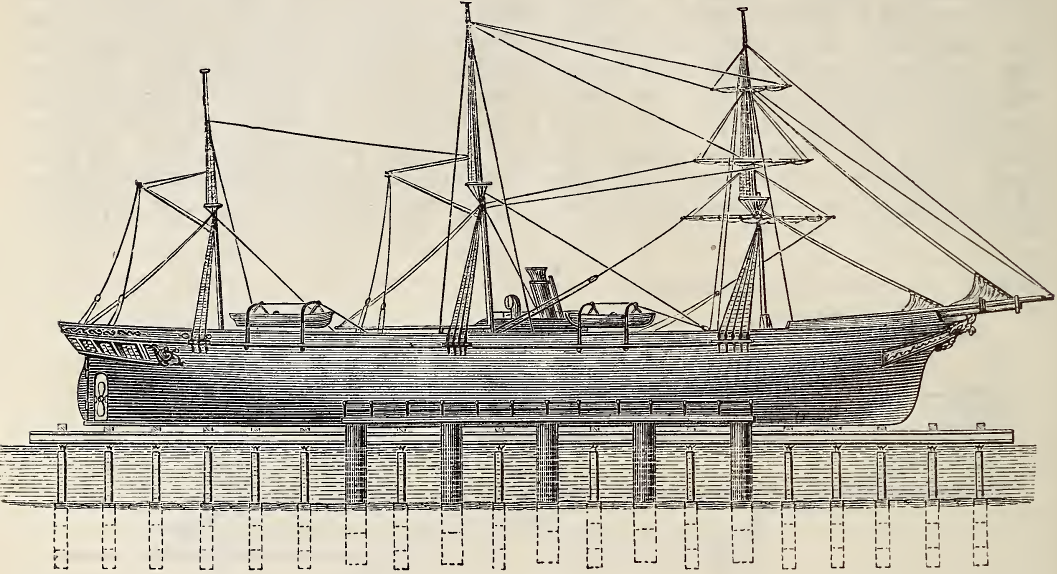


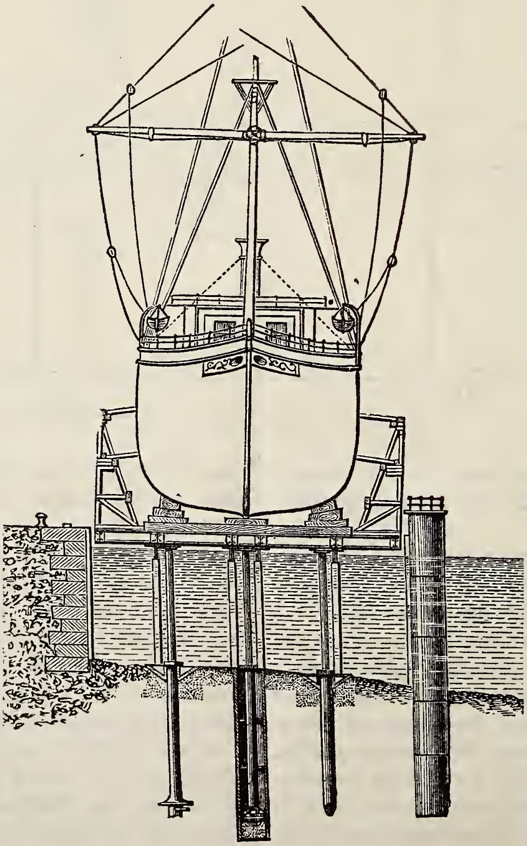
Another very important improvement which this firm has effected in lifts is this. Suppose that a bridge has to be lifted by rams at its ends. Suppose the presses of these rams are connected with an accumulator, they are not likely to rise equally fast, and the bridge would be tilted; indeed, one of them may not rise at all, and the other may be rising quickly. Again, suppose we have a separate accumulator for each separate press, so that there is no water communication between them, great care has to be taken at the valves to make the ends of the bridge rise equally fast. This difficulty is got over by having two presses and two rams on the accumulator. Now, let each accumulator press be connected with each bridge press. The frame carrying the accumulator weight is guided so that it cannot tilt; each equal ram, therefore, falls the same amount as the other, and the equal bridge rams must rise as much the one as the other.

When a large structure has to be lifted, the lifting presses which get this synchronous action are so distributed in supporting the structure, that there is no tilting of it possible.

Thus Fig. 5 shows Clark and Standfield's hydraulic grid. The strong girder, A, with its projecting ribs, rests on the ends of a number of rams, whose presses are sunk in the bed of the dock or tidal river. The keel of a vessel is brought directly over A, and secured in position by the bilge blocks and side-shoring frames, the presses are worked, and the rams lift the grid and the vessel above the level of high water. Now a number of struts, which were previously held up horizontally, are liberated, and hang from the grid alongside the rams; on lowering the rams, the lower ends of these struts fit into the tops of the presses, form a support for the grid, and the rams are withdrawn into their presses.

Fig. 5.

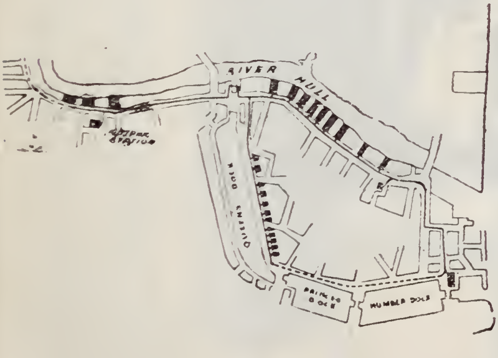




There are only a few guide columns needed for the grid to slide against as it rises and falls, because the presses are arranged in three equal groups on the above-mentioned principle, supplemented by an automatic safety valve, which lets the water escape from a press when its ram has risen more than the others. Hence the grid must, when rising and falling, remain perfectly level.

I now come to the last part of my subject, the transmission of power to a distance by means of water. You know that at present power is transmitted from a steam-engine to all parts of manufactory by means of ordinary shafting and tooth or belt gearing. You know also that wherever solid surfaces, such as those of a shaft and its seat, or the teeth of wheels, rub on one another, you have a kind of friction which increases nearly in proportion to the forces or torques transmitted, and which constitutes a pretty large waste of energy even when the power transmitted is very small. You know also that power can be transmitted considerable distances by long ropes carried by pulleys, as, for example, from a waterfall on a mountain to a village half a-mile away. This method is adopted at Schaffhausen and other places. Again, power is transmitted by means of compressed air in pipes into tunnels, for the working of rock-drills. The defect of this plan is in the heating of air when it is compressed, and cooling when it is used. Again, coal-gas may be transmitted in pipes, to work small or large gas-engines at distant places. With these methods of power transmission you are all tolerably familiar, and I have to put before you the principles of its transmission by means of water.

Mr. Bramah, in 1802, contemplated the working of all the cranes on docks and in warehouses by water sent out under pressure from a central station, but the idea was not carried out till many years later, when Sir William Armstrong made the idea a reality, and he may be said to have created a new branch of engineering. In all large engineering establishments, now-a-days, there is such a central station where water is pumped into an accumulator, from which it is supplied to all manner of lifts and cranes; and, in the last ten years, Mr. Tweddell has perfected the application of the method to certain kinds of tools. But in truth, we are only at the beginning of the realisation of Mr. Bramah's idea, for it is only ten years since the Hull Hydraulic-Power Company was incorporated, and I consider the relation of this to Sir William Armstrong's success, to be like supplying a whole town with gas in comparison with supplying one establishment with gas.



What, now, does this company do? Here you see a station where two centrifugal pumps bring water from the river to this tank. Two pairs of reciprocating-pumps now supply this water to an accumulator, at 700 lb. per square inch. The ram is 18 inches in diameter, stroke 20 feet, total load 80 tons. On the map you will see how a six inch cast-iron pipe leads off the pressure-water from the accumulator, just as gas is led off from a gas-holder. Any person living near this line, who wants to work a hoist or crane, to drive a water-pressure engine for any purpose, such as that of haulage, can get a supply of this pressure-water which will do work for him when he opens his tap. And pray remember that every cubic foot of water he draws from the main can give up for his benefit 100,800 foot-pounds of work; that is can exert a horse-power for three minutes. Remember, too, that the instant a person closes his tap, that instant he ceases to receive power. His crane or other engine works only when he keeps his tap open, and whether he keeps it working regularly or intermittently, he wastes no energy, and nobody is the loser by his working by fits and starts, instead of in a regular manner. If he used a gas-engine or steam-engine to drive his hoist or other machine directly, he would waste a great deal of energy by his intermittent action. When I come to the next part of my subject, you will see better the important control which the user has over the working of his machines.

Each consumer makes a yearly payment for a certain specified quantity of pressure-water, and beyond this quantity is charged at the rate of 4s. per 1,000 gallons, that, is he receives one-horse power for 6d. an hour. Mr. Ellington gives the cost of ordinary working, including waste, leakage, light loads, and idle lifts, in the lifting of grain by a sack-hoist like this, of which a diagram was shown on the wall. Calculating from his figures, I find that, paying attention to the work actually done, the weight of grain actually lifted, the consumer pays 1s. 1½d. per hour per horse-power. It has to be remembered also that few men are needed in such work, the hoist is under the most perfect control, and can be stopped at any instant; the work is rapid and safe. Even in working a small "Brotherhood" water-pressure engine, such as I described to you in my last lecture, it seems that only about 1s. 4d. is paid per hour per horse-power for work actually performed in haulage—performed uniformly or intermittently.

I have one more fact to put before you. Mr. Ellington says, in a paper published last year, that for the eighteen months previously no repairs had been needed in this mile of six inch pipes, sunk two feet below the street, and meandering in the most confused manner among gas and water mains, under exceptionally unfavourable conditions of soil and traffic.

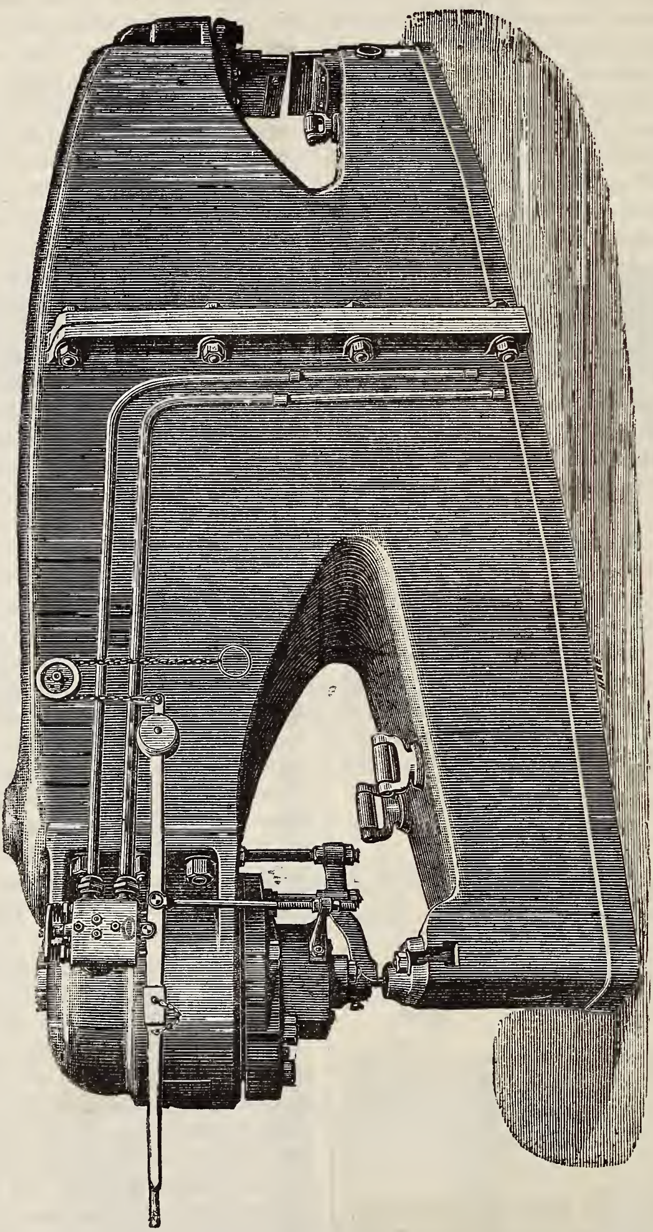


Fig. 6.

And now, supposing it is easy to get such a supply of pressure-water, what, besides cranes, hoists, and pressure-engines, can be worked by means of it. All forging and welding machines, which with moulds and dies properly shaped and pressed together with enormous steady force, seem, for objects of settled shapes, to be a very great improvement on any method of hammering; stamping machines, for all sorts of purposes; bending machines, for joggling and bending angle-irons, rails, and beams.

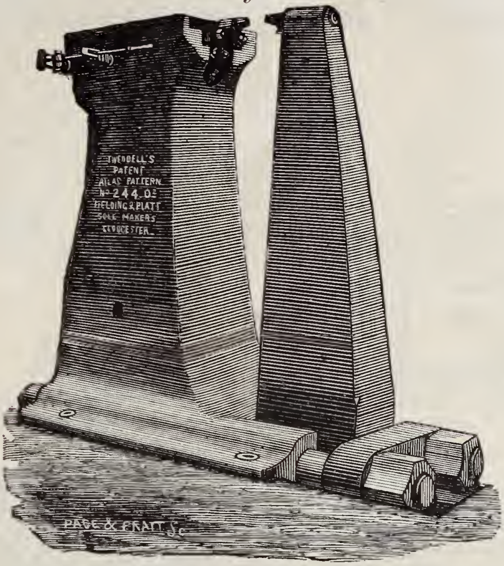
Here, for example, is one. A right and left-handed screw carries the abutting blocks. The travel of the press-block is determined by tappets, which open and close the valve for water supply at any point in the stroke we please. By means of this any number of curves may be made identically the same.

In Fig. 6 we see one of Tweddell's Hydraulic Punching and Shearing Machines. It is in two parts, each of which may be used independently of the other. One is for shearing, forging, or stamping, the other for punching. The inlet and exhaust valves are worked by a hand or foot lever. The stroke of each ram can be regulated with great nicety by a tappet motion.

In this diagram (Fig. 7, p. 1003) we have a fixed hydraulic riveter, whose ram is only 8 inches in diameter, but as the water-pressure is very great, the total pressure on the die is thirty-four tons. It is used with an accumulator and pumps of its own, so that it may be kept at work continuously, without having to keep the shop engines running. The flame from the rivet-heating furnace raises steam in a boiler to drive the accumulator pumps.

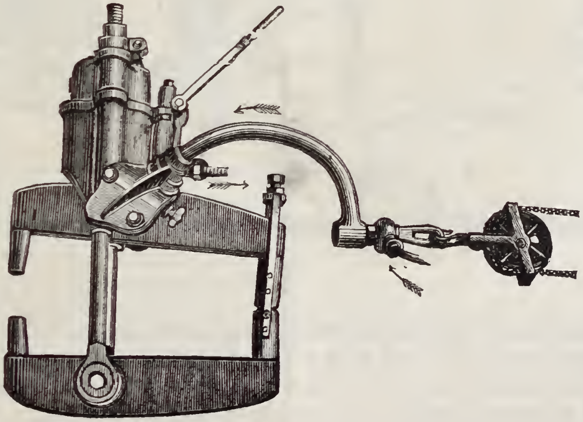
The pressure-water is admitted to the cylinder by a valve, which is opened by a lever against the water-pressure, and the pressure of a spring. The exhaust valve is kept shut by the water-pressure and the spring, till the lever opens it, letting the pressure valve close at the end of the stroke. The exhaust water now flows back to the pump cistern, part being drawn to cool the die; because there is always pressure-water in that space, and this now draws the ram back. The man can begin and end his stroke where he pleases. The handle unships readily, and is taken away by the man if he leaves the machine.

Fig. 7.



Next, we have tools which are easily portable. Thus Fig. 8 shows a tool weighing 5 cwt., which is used for some of the heaviest riveting work in furnace rings, beams, girders, &c. The centre of the piece is held fast by two tension rods, whose lengths are adjustable. The centre of the piece is pushed by the ram. One pair of ends come together and act as a fulcrum, and the riveting is performed at the other. Eye bolts in various positions enable this tool to be suspended in a convenient manner about the work on which it is employed. [A few of these positions were shown in Fig. 9 (p. 1004) and other diagrams.]

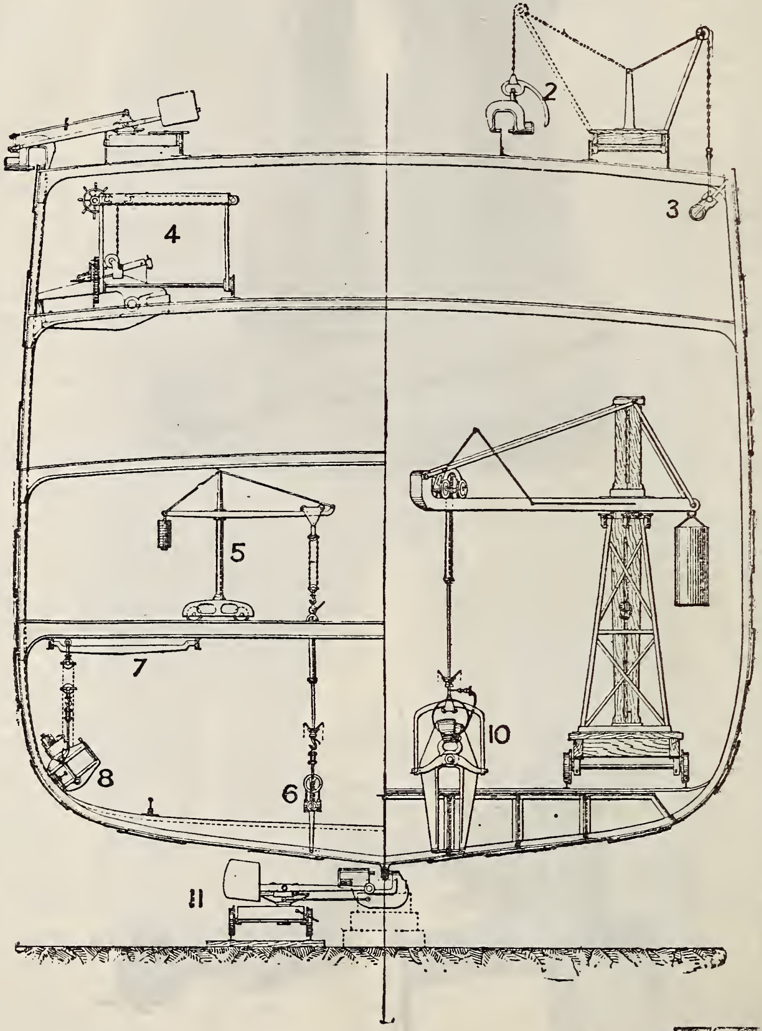
Fig. 8.



In another form of this riveter the dies are in a line with the ram. In all respects the cylinders and rams of these machines are the same as that of the fixed riveter already described. [The model of a more modern form shown in Fig. 10 (p. 1005), designed by Mr. Fielding, was also here exhibited.] The ram here gets a motion about its centre, its line of action being an arc of a circle. By this compact arrangement we do away with connecting-rods and many other complications, and we get a great increase in stiffness. Instead, then, of bringing work weighing many tons to a machine, we bring this little machine, weighing 5 cwt., to the work; we can punch holes and finish the riveting; that is we can finish most of it — for there must always remain rivets in difficult positions which require to be done by hand —with no other intermediate gearing between this little riveter and the steam-engine than a small jointed pipe. Here are two forms of the universal joint which is used, made water-tight by leather collars. Instead of a jointed pipe, a pipe formed into a spiral forms a good yielding connexion. It is, perhaps, in looking at these little riveters, rather than in any other examples, that you will be struck by the simplicity of hydraulic working. This flexible pipe transmits power more faithfully than huge beams and cog-wheels would do.

In Fig. 11 (p. 1006), we see the general arrangement of the riveting plant used in 1873, on a large girder-bridge, at Primrose-street. The furnace heats the rivets, and also the steam boiler. The little engine works the pumps, which feed the differential accumulator, 4, from which pressure-water feeds the riveters. There is all the necessary gearing for traversing, swinging, hoisting, and altering the radius of the gib, and the crane can lift any weight up to one ton. Hence it not only rivets, but helps in other ways, in the bridge construction. Punching and shearing-machines are combined with it when required, and Mr. Tweddell has come to the conclusion that one set of hand riveters, in addition to the machine, will do the work of six sets without it, and, especially in the case of heavy work, will do it better.

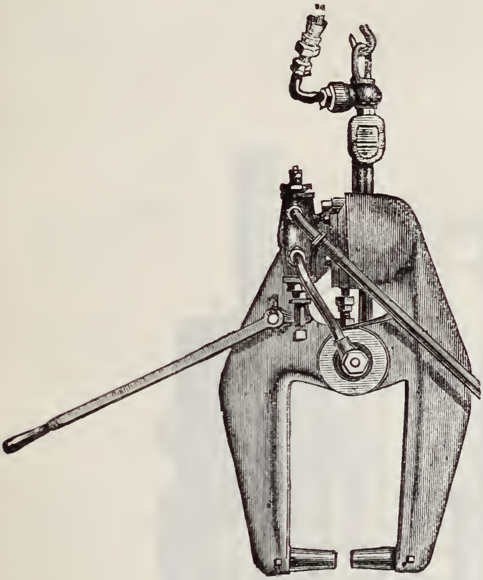
Fig. 9.



In another diagram we see Mr. Tweddell's arrangement for doing work in country districts. He has here dispensed with the ordinary accumulator. I pointed out, in my last lecture, that the total weight of water in a tank A, at a short distance, may be made to act like the total weight placed on an accumulator. This water flows from A to D, or from D to A, but is not wasted. E is the accumulator-press. The pressure-water is pumped into E by means of a portable engine, or by a horse gin, or in any other suitable way. The accumulator may move about along with the riveter, so long as we do not go very far away from the fixed tank, A, and so long as the pipes, B, are wide, and have easy bends.

Now, you will observe that in no case does Mr. Tweddell endeavour to drive lathes or planing machines which have pretty regular speeds, but vary in the power required. The machines to which he applies his hydraulic methods of working are very different. A punching, or shearing, or stamping, or riveting machine, driven by shafting, repeats its stroke at regular intervals, and the workman cannot arrest a stroke. He wastes time in waiting for a stroke, but when a stroke is being made, and he sees that his plate has been wrongly placed, or has shifted its position, he must just as patiently watch the inevitable completion of the stroke. With the hydraulic punching-machine, on the contrary, the workman can stop the motion at any instant, even if the punch has made its mark on the surface of the plate. He can start instantly from a condition of rest, he has not to wait till he pulls the belt on to the fast pulley, or starts the donkey-engine, and he knows that when there is no stroke being made, there is no power being wasted. Then, again, all the shafting and other machinery of a large shop have not to be set in motion, or varied in their motion, to punch a ⅝ths of an inch hole. A man wastes just the same energy in punching this one hole as if it were one of a hundred he was punching. Suppose, again, that a man carelessly puts a 1¼-inch plate under a punch arranged for a ⅝ths inch plate. The sudden blow of an ordinary punching-machine, with its fly-wheel, would produce a fracture somewhere. In a hydraulic-machine there is a simple stoppage. Think, too, of the strength of roof and columns needed to carry shafting; of the trouble in the use of overhead cranes when there are many shafts and belts, and, above all, think of the noise, in comparison with the invisibility of pressure mains, and the dead silence of hydraulic tools. Observe, too, that these hydraulic machines need but little foundation.

Fig 10.



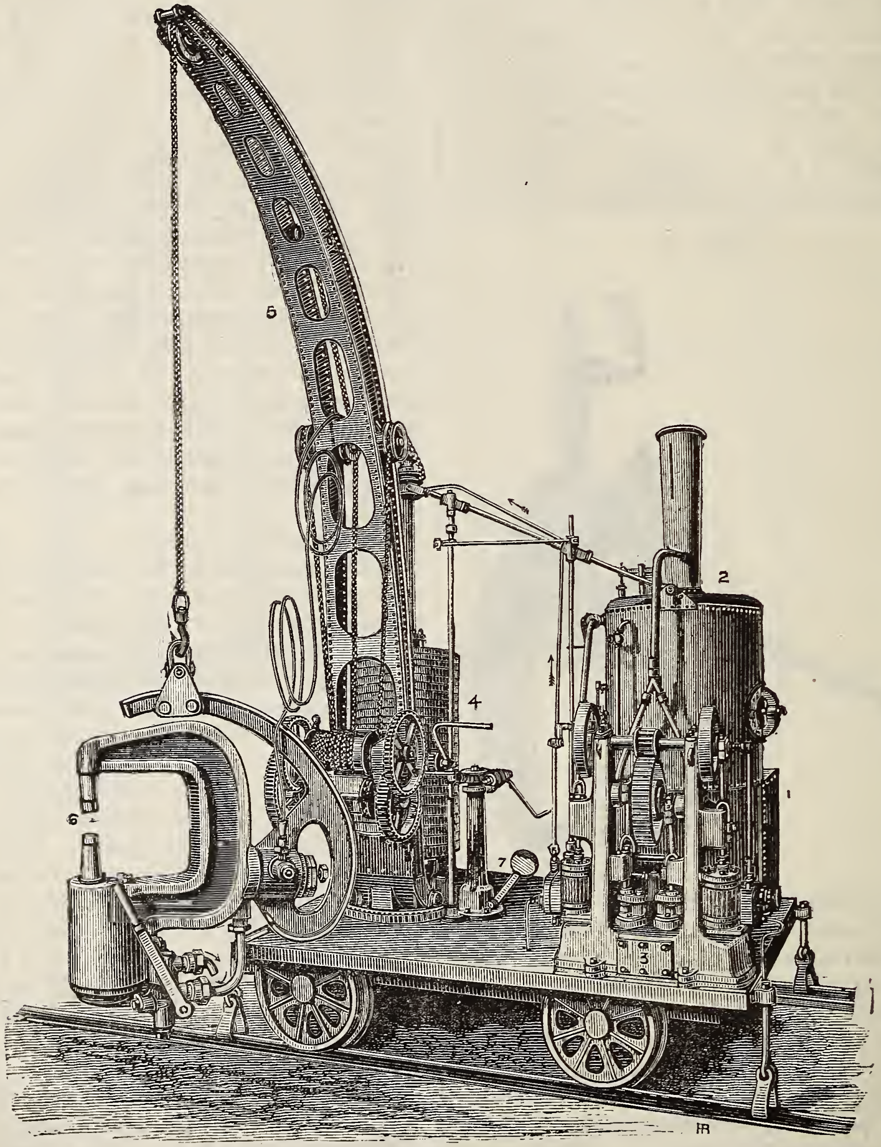
These diagrams (given in Figs. 12, 13 and 14, p. 1007), showing the water-pressure in the cylinders of various tools at Toulon during their stroke, are exceedingly interesting. Fig. 12 shows a curve from a punching-machine. The pressure is not equal to that in the accumulator, unless the tool has so much resistance to overcome, that it is moving very slowly indeed. The sudden rise shows what occurs when the punch is just beginning to act on the plate. In practice you must understand that this early part of the diagram has no existence. Mr. Tweddell's tappet motion prevents such waste. The area of each diagram is roughly the amount of energy utilised. The area of the dotted rectangle shows the energy taken from the accumulator. In all these diagrams then it must appear to you that there is a large amount of waste. This is greatly reduced by the tappet motion, and in any case it is very much greater in such tools when driven by shafting.

Fig. 13 shows a diagram from a plate-shearing machine. The uniformity of the pressure is due to the angle which the edges of the shears make with one another.

The riveting-machine diagrams are most interesting. Neglecting the useless part of the stroke, which ought not to have been shown here, in Fig. 14 we see the rise of pressure, E F, due to the setting up of the rivet, F H, the clinching of the rivet and closing of the plates. The sudden stoppage of motion of the water gives a blow, shown by the pressure becoming half as much again as the accumulator pressure, and Mr. Tweddell relies on this blow as perfecting the filling of all cavities. You will see by these specimens which I show you, that the work done by hydraulic machines is very good indeed, especially in those most difficult cases where, in bridge-work, one rivet passes through a number of plates. These specimens of riveted plates have been carefully planed down half way through the rivet.

And now, having shown you how convenient it is to work these machines by water, let me say that I know of nothing which is more instructive than these curves. When there is very little opposition to the motion of the ram, it gets considerable velocity, the water in the press moves rapidly; and it has been usual to imagine that we had the means of calculating the loss of energy in the pipes, due to friction under such circumstances; but no method of calculation, no theory of the action, will quantitatively account for the enormous loss observed here. If there were no friction, this enormous change in pressure, from 1,600 to 50 pounds per square inch, would mean that there was a change into kinetic energy, but it would mean a velocity of the water of 480 feet per second. No measurements seem to have been made of the velocity of these tools at different points in the stroke, but it is very probable that only a very small portion of the energy is in the kinetic form. Suppose, now, that the water of our accumulator is capable of overcoming a ram resistance of thirty tons, and suppose that the real resistance is only two tons, then every pound of water wastes 28 × 2240 × 2·3 foot-pounds of energy, and utilises 2 × 2240 × 2·3 foot-pounds of energy. Suppose, now, that the water of the accumulator had been capable of overcoming a ram resistance of only fifteen tons, and there

Fig. 11.



was a real resistance of two tons, then every pound of water wastes 13 × 2240 × 2·3 foot-pounds of energy, and utilises 2 × 2240 × 2·3 foot-pounds of energy. The waste is directly proportional to the difference of pressures. Now, I would ask, is there a great difference of velocity in these two cases; certainly not. But, usually, we suppose the waste in hydraulic machines to be independent of pressure, and to be dependent on velocity, and yet I know that if we could give this same ram the same velocity in some artificial way, when the water pressure was comparatively small, there would be a small loss by friction in the water. We are compelled, then, to come to the conclusion that with nearly the same velocities in any hydraulic arrangements, we have far more frictional loss when the pressure is great than when it is small. If you ask me how I can explain this apparent discrepancy from received ideas, I can only say that to me the subject is quite chaotic. No systematic experiments have been published on water friction at great pressures, and with no experimental facts to go upon, I cannot understand how it is that Mr. Tweddell gets only this small amount of impulse action at the end. The area of this bit of curve, G H, (Fig. 14) is all there is to represent the reconverted kinetic energy, and yet to obtain this it is necessary for a small accumulator to be close to the riveting machine.

We may look for explanation, first, in the supposition that when water alters in pressure, the change of strain, involving as it does conversion of energy into heat, thus involves considerable waste; second, in the supposition that as every tube, every solid surface bounding the liquid alters in strain, getting larger and smaller with change of pressure, this strain energy when it alters in amount causes great waste.

Fig. 12.

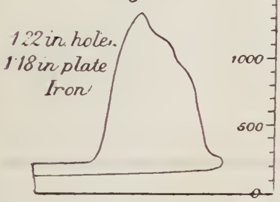


Fig. 13.

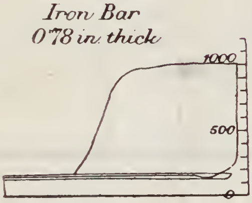
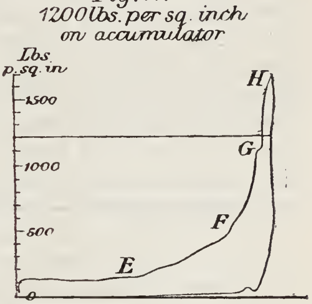


Fig. 14.



However this may be, it seems certain that, when the flow of water is unsteady, there is far more loss of energy when the pressure is great than when it is small. It would seem also that, when the fluctuation originates in places of higher pressure, there is less loss than when it originates in places of lower pressure; for a reciprocating pump is always more efficient on high lifts than on low lifts at the same velocity.

In the absence of experimental evidence, we can only fall back upon our knowledge of such pressures as are common in town water supply, and our knowledge of reciprocating pumps, and continue to assume that water friction, *when the motion is steady*, is independent of pressure. What is the reason why we get such good results in working hoists and cranes by water? The water which comes along these pipes possesses great pressure energy. The more water that flows in these pipes, the more loss there is in friction; but the power sent along depends on two things—the quantity of water per second, multiplied by its pressure. Increase the pressure then, and send the same amount of water; you have the same total loss of energy by friction, but you have transmitted much more. Suppose Mr. Tweddell can make his joints as safe from leakage as Armstrong can his, every pound of water that Mr. Tweddell sends, at 1,500 pounds pressure, contains 3,400 foot-pounds of energy; and every pound of water that Armstrong sends, at 750 pounds pressure, contains 1,700 foot-pounds of energy. Suppose they send the same quantity of water steadily along the same pipes, and that Armstrong loses 300 foot-pounds of energy per pound of water, then Tweddell loses the same amount. That is, the one wastes 18, and the other 9 per cent. of his total energy in transmission along the same pipes. But there is really more than twice the efficiency, for if Tweddell sent only the same amount of energy as Armstrong, he would use only half as much water, that is, the velocity everywhere would be halved, the kinetic energy would be quartered, and, as frictional loss in steady motion is proportional to the kinetic energy, there would be only 75 foot-pounds of loss in friction, with the high pressure arrangement, and hence, instead of 9 per cent., we have only $2\frac{1}{4}$ per cent. waste. In fact, then Armstrong would have 18 per cent., and Tweddell only $2\frac{1}{4}$ per cent. of waste. Of course, however, Tweddell's pipes being of the same diameter, would have to be much thicker and more costly.

To take the general case of transmission of power by water, Darcy's experiments tell us that each pound of water loses $f\frac{4L}{d}$ times its kinetic energy in flowing along a straight pipe of diameter d feet, length L feet, where f may be taken for a new 6-inch pipe, 0·0058. Or if Q cubic feet of water flow per second, and if P was the original pressure in pounds per square inch, then ·262 P Q is the horse-power which enters the pipe, and $\cdot 0000665\ L\ Q^3 \div d^5$ is the power lost on the way. Thus, if E is the horse-power entering the pipe, the power lost is

$$\cdot 00025\ \frac{L\ E^3}{d^5\ P^3}$$

Hence, taking a 6-inch pipe with the pressure of 700 lbs. used by Sir William Armstrong, we obtain the above results.

PRESSURE 700 LBS. PER SQUARE INCH AT ENTRANCE.

Horse-power given in.	Horse-power lost in one mile.		Horse-power lost in ten miles.		Horse-power lost in 100 miles.		Horse-power lost in 1,000 miles.
	6-inch pipe.	3-inch pipe.	6-inch pipe.	3-inch pipe.	6-inch pipe.	3-inch pipe.	6-inch pipe.
500	·125	4	1·25	40	12·5	400	125
1,000	1·0	32	10	320	100	..	..
2,000	8	256	80	..	800	..	..
4,000	64	2048	640	..	..	..	..
8,000	512	..	5120	..	..	..	..
16,000	4096	..	..	..	..	..	..
32,000	..	..	..	..	..	..	..

PRESSURE 1,400 LBS. PER SQUARE INCH AT ENTRANCE.

Horse-power given in.	Horse-power lost in one mile.		Horse-power lost in ten miles.		Horse-power lost in 100 miles.		Horse-power lost in 1,000 miles.
	6-inch pipe.	3-inch pipe.	6-inch pipe.	3-inch pipe.	6-inch pipe.	3-inch pipe.	6-inch pipe.
500	.015	·5	·15	5	1·5	50	15
1,000	·125	4	1·25	40	12·5	400	125
2,000	1	32	10	320	100	..	1000
4,000	8	256	80	2560	800	..	..
8,000	64	2048	640	..	6400	..	..
16,000	512	..	5120	..	..	..	..
32,000	4096	..	..	..	..	..	..

At these high pressures you see what a marvellous efficiency we have in the transmission of power. Compare it with such a low pressure as seventy pounds per square inch, for example, and we find that in one mile the results are as given in the annexed table.

Horse-power given in.	Horse-power lost in one mile.		Horse-power lost in ten miles.	
	6-inch.	3-inch.	6-inch.	3-inch.
500	15·6	..	156	..
1,000	125	..	..	..
2,000	1000	..	..	..
4,000	..	..	..	..

Suppose that S is the working tensile stress of the material of the pipe per square inch, taking Lamè's law for the strength of the pipe, assuming that there is a loss of 5 per cent. per annum on capital; that v pounds is the cost price of pipes per cubic inch of metal used; and that e pounds per annum is the price of a horse-power day and night, it is easy to show that in every foot of a pipe there is a total loss per annum of

$$\cdot 00025 \frac{\mathrm{E}^3 e}{d^5 \mathrm{P}^3} + 135\cdot 7 \frac{d^2 \mathrm{P} v}{\mathrm{S} - \mathrm{P}}$$

I also add a term here expressing the repair expenses.

Now, it is easy to find when this is a minimum, that is, it is easy to find when we want to transmit a certain amount of power, what, on the whole, is the best pressure, and the best diameter of pipe to employ. It would take me too long to give you, verbally, the results of such an investigation.

Now, I entered into this investigation to show you that, with high pressures, it is possible to transmit an enormous amount of horse-power great distances, through moderately small straight pipes, with but little loss. Neither mere distance nor cost, then, introduces obstacles to the transmission of the whole power of Niagara over the United States. It is the bends, the shocks, the difficulty of using the power when it arrives, by means of quick-moving engines, these are the things to fear in such transmission of energy.

Remember that we convert our energy at a place, A, into pressure energy of water, and this must be performed by pumps which move with only a moderate speed. If our source of power is a waterfall, this works a turbine; the quick-moving turbine has to work slow-moving pumps. Then at the distant place, B, to be sure, we receive the water with only a small diminution of its pressure energy; but you saw that in cranes and hoists, and even in those beautifully arranged tools, it was not so much economy in use as something else that made the use of water so convenient.

I have now to tell you of the competitor of water for the transmission of power, electricity. Many of you who were here last year saw me work machines in this room by means of power transmitted through wires from a steam-engine working in the Adelphi-arches. Here is a little motor which I use for a variety of purposes. I can turn a heavy lathe with it, I can work a sewing-machine, and it is supplied with power through these thin wires. I can store this electrical energy in such quantity that, from the little box before you, Professor Ayrton and I have drawn more than 1,400,000 foot-pounds of energy, leaving an unknown quantity behind. We can store and discharge more than 80 per cent. of our storage; in some cases more than 90 per cent.

Some of you, two weeks ago, saw Professor Ayrton work Hopkinson's lift at the London Institution with electricity drawn from little boxes of this kind. Others of you may have travelled on the tramway at Leytonstone, and seen the store drawn from these boxes working the tram-car.

I showed last year how probable it was that, in the not very distant future, we should burn the coal in our coal pits, and send its energy to distant towns in the form of electricity. Remember that the generators of electrical energy can work fast or slow, but they are more efficient when they work fast.

You can drive them by steam-engines, or by turbines, or by wind-mills. The electric energy has no difficulty in going round corners, its wires need not be straight, they will not suffer from the winter's frost. In a workshop the electricity comes by wires, which may be well hidden, to such motors as this, and each machine in a shop may have one, or there may be one for the whole shop, or there may be a general one for the whole shop, and also others on special tools, there being much the same efficiency in every case. They reconvert the electrical energy into mechanical energy, and they can work either fast or slow, but they are more efficient when they work fast. Their rotating parts have so little moment of inertia, that they may be stopped and started with very little loss indeed. We cannot drive railway trains by water, but those of you who were at the Royal Institution on Friday night, know that the working of the longest railway lines by electric power is not only feasible, but is far more economical, and is ever so much safer than the present steam locomotive method.

The law I have given you for transmission of power by water is exactly the same as the law for electrical transmission:—

The horse-power put into a pipe at the place A : the horse-power taken out of the pipe at the distant place B :: the pressure at A : the difference of pressures at A and B.

The horse-power going into a wire at A : the horse-power taken out of the wire at distant place B :: potential at A : the difference of potentials at A and B.

And just as we saw that great pressure is a necessity for efficient transmission of power by water, so great potential is the necessity for efficient transmission of power by electricity.

Great pressure means great tendency of water to escape, to burst the pipe.

Great potential means great tendency of the electricity to escape, to burst through the covering of the wire as a spark.

It has been calculated by Sir Wm. Thomson that 26,250 horse-power can be quite safely brought 300 miles from Niagara through a ½ inch copper wire, with a loss in transmission of 20 per cent., and not only can this be done, but the power can be utilised, through the agency of Faure batteries, in such a way that the users of the power are absolutely in no danger of shocks.

But while I think that general transmission of power will in the future be effected electrically, I know that for special cases of power transmission hydraulic methods have the advantage. I cannot imagine pressing machinery worked by electricity, nor any one of the tools of which I have spoken to-night. As I have already hinted, I believe that turbines have a great future before them, not in opposition to, but in consequence of, electrical development. Electricity cannot work canal lifts, nor do I see any chance for it in crane work; and when certain sanguine electrical people speak of electrical methods of working hotel hoists, I feel that, if such a useful future is in store for them, they must be as the adjuncts of Mr. Ellington's hydraulic balance method. Hydraulics will do the balancing, and electricity will produce the motion.

I feel sure that large installations of electrical and hydraulic transmission of power will shortly take place, and as I have given the law of hydraulic transmission, I think it well to give the corresponding law of electric transmission.

If P is the electro-motive force or difference of potential in volts, produced by a generator of electricity (this corresponds with pressure in water), E is the horse-power given by generator to wire.

$$\text{Horse-power wasted in transmission} = \frac{E^2}{P^2}\,746\,R.$$

Now for copper wire one inch in diameter, the resistance of one mile is 22 ohms. Therefore, if l is distance in miles—

$$\text{Wasted horse-power} = \frac{E^2}{P^2}\,.\,746\,.\times.\,\frac{22\,l}{d^2}$$

$$= 164\,\frac{E^2\,l}{d^2\,P^2}$$

The following tables give an idea of the loss in transmission of power:—

POTENTIAL 80,000 VOLTS.

Horse-power given to wire.	Horse-power lost in one mile.		Horse-power lost in ten miles.		Horse-power lost in 100 miles.		Horse-power lost in 1,000 miles.	
	½-inch wire.	¼-inch wire.	½-inch wire.	¼-inch wire.	½-inch wire.	¼-inch wire.	½-inch wire.	¼-inch wire.
500 ……	·007	·027	0·7	·27	·7	2·7	7·0	27
1,000 ……	·027	·108	·27	1·c8	2·7	10·8	27·0	108
2,000 ……	·108	·432	1·08	4·32	10·8	43·2	108·0	432
4,000 ……	·432	1·728	4·32	17·28	43·2	172·8	432·0	1728
8,000 ……	1·728	6·912	17·28	69·12	172·8	691·2	1728·0	6912
16,000 ……	6·912	27·648	69·12	276·48	691·2	2764·8	6912·0	..
32,000 ……	27·648	110·592	276·48	1105·59	2764·8	11055·9	..	..

POTENTIAL 8,000 VOLTS.

Horse-power given to wire.	Horse-power lost in one mile.		Horse-power lost in ten miles.		Horse-power lost in 100 miles.		Horse-power lost in 1,000 miles.	
	½-inch wire.	¼-inch wire.	½-inch wire.	¼-inch wire.	½-inch wire.	¼-inch wire.	½-inch wier.	¼-inch wire.
500 ……	·00007	·00027	·0007	·0027	·007	·027	.07	·27
1,000 ……	·00027	·00108	·0027	·0108	·027	·108	·27	1·08
2,000 ……	·00108	·00432	.0108	·0432	·108	·432	1·08	4·32
4,000 ……	·00432	·01728	·0432	·1728	·432	1·728	4·32	17·28
8,000 ……	·01728	·06912	·1728	·6910	1·728	6·912	17·28	69·12
16,000 ……	·06912	·27648	·6912	2·7648	6·912	27·648	69·12	..
32,000 ……	·27648	1·10592	2·7648	11·0559	27·648	110·559	..	..

Miscellaneous.

THE MECHANICAL PROPERTIES OF ALUMINIUM.*

By W. H. Barlow, F.R.S.

Having had occasion to use aluminium in the construction of instruments adapted for special purposes; and having observed that it possessed a remarkable degree of strength, in proportion to its weight, and a large range of elastic action, it appeared to me desirable to ascertain more fully the mechanical properties of this metal.

With this object, a bar of aluminium, three feet long and a quarter of an inch square, was obtained, and different parts of this bar were subjected to test, for tension, compression, and transverse strain; and also to ascertain the modulus of elasticity, the elastic range and ductility.

The experiments were carefully carried out for me under the able direction of Professor Kennedy, with his testing machine, at the London University; and the results are given at length in the table appended to this paper.

It will be seen, on reference to the results obtained that the weight of a cubic inch is ·0972 lbs., showing a specific gravity of 2688, and that its ultimate tensile strength is about 12 tons per square inch. The range of elasticity is large, the extension at the yielding point being $\frac{1}{200}$ part of its length. The modulus of elasticity is 10,000. The ductility of samples, 2 inches long, was only 2·5 per cent.; but it is probable that the metal could be improved in this respect.

Taking the tensile strength of this metal, in relation to its weight, it shows a high mechanical value. Its characteristics in this respect, as compared with those of other well-known metals, are shown in the following summary:—

	Weight of a cubic foot in lbs.	Tensile strength per square inch, in lbs.	Length of a bar which is just capable of bearing its own weight.
			Feet lineal.
Cast-iron........	444	16,500	5,351
Bronze..........	525	36,000	9,893
Wrought-iron....	480	50,000	15,000
Steel of 35 tons per inch	490	78,000	23,040
Aluminium......	168	26,880	23,040

It thus appears that, taking the strength of aluminium in relation to its weight, it possesses a mechanical value about equal to steel of 35 tons per inch.

Aluminium is, unfortunately, a very expensive metal, and although an increased demand might lead to a considerable reduction in price, yet the process by which it is extracted leaves little hope at present of obtaining it at a rate sufficiently low for general use. But its mechanical properties point to its suitability for those cases where strength, combined with lightness and a great range of elastic action, are required. The elastic range is about three times that of steel, and about five times that of wrought iron.

In the discussion, Sir H. Bessemer said that experiments had been made, and others were in hand, by which it was expected to obtain a new process, which would very greatly reduce the cost of manufacture. He also produced a door-key, made in aluminium, stating that 40 of such keys would only weigh 1-lb.

It may be added that Sir Wm. Thomson uses aluminium for the rims of his very excellent compasses for ships.

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* A paper read before the Mechanical Section of the British Association, at Southampton.

PATENTS FOR INVENTIONS FOR 1881.

The annual report of the Commissioners of Patents for the year 1881, has just been issued. It states that the number of applications for letters patent for the year was 5,751, being 234 more than for the preceding year, which exceeded considerably the number of any former year. The number of letters patent sealed was 3,948, of which 68 lapsed in consequence of the patentees having neglected to file final specifications in pursuance thereof, leaving 3,880 in force. Of this latter number, final specifications were filed in respect of 3,621; complete specifications being filed in respect of 259. Applicants failed to seal their patents in 1,798 cases; opposition was offered in four cases; and one application stands over through the decease of the applicant. A table is given, showing that about 65 per cent. of the applications for patents, from 1852 to 1881, became valid patents; that of the valid patents obtained upon the applications from 1852 to 1874, nearly 30 per cent. paid the third year's stamp duty of £50 and continued in force until the end of the seventh year; and that about 10½ per cent. paid the seventh year's stamp duty of £100, and consequently remained in force for the full term of fourteen years. The report gives the usual list of the Commissioners' publications, including the classified abridgments which are now to be published in volumes for decennial periods. The number of classes now published is 99, and it is stated that the classification will be completed in about 110. The index to the contents of the specifications filed previously to 1852, commenced in 1878, is not yet complete, but as additional clerks have been engaged to assist in the work, it may be assumed that it will be published before very long. The receipts from the sale of publications during the year 1881 amounted to £2,912. The stamp duties received amounted to £196,831. The profits realised by the office amounted to £163,441. The total amount earned by the office, since its establishment in 1852, is not stated as in most former reports, but it must now be more than £2,000,000. The Patent Museum at South Kensington has been visited during the year 1881 by 282,121 visitors. During the year 1881, 91 ornamental, and 137 useful designs were provisionally registered; and complete registration of 15,176 ornamental, and 128 useful designs was effected. There were also three designs registered for sculpture.

CULTIVATION AND PRODUCTION OF PINE-APPLES IN THE BAHAMAS.

The cultivation and shipment of pine-apples is, according to Consul McLain, the most important industry of the Bahamas, much capital, and very many people being employed in it, so that the material prosperity of the colony, from year to year, depends largely upon the success or failure of the crop. Of the several varieties of pine-apple, only two are considered profitable to cultivate for exportation, the "scarlet," or Cuban pine, and the "sugar-loaf." The former was introduced to the Bahamas from Cuba, in 1850, and is now the leading variety of commerce; the latter, a very luscious fruit, is exported principally to England. The Bahamas generally are noted for the thinness of the soil, which seldom exceeds a depth of from six to eight inches. The islands are composed largely of a species of limestone, made up of sand, carbonate of lime, and the remains of myriads of defunct coral insects, so that the rock itself is a very good fertiliser; in fact prolific vegetation flourishes apparently upon the bare rock, the surface of which is broken and honeycombed, the small openings being full of vegetable mould, and furnishing holding-places for the roots of not only plants and grasses, but often of large and stately trees. The ordinary soil of the Bahamas is not fitted for the cultivation of the pine-apple, as this plant requires a depth of at least two feet to be grown successfully. But upon many of the islands, extensive tracts of soil are found, composed of a reddish clay, about two feet deep, and these are peculiarly adapted to the pine-apple; this soil is very rich, being, as geologists say, composed of the decayed remains of decomposed vegetable life, and the *débris* of shell-fish and coral insects, each cubic foot of the soil representing the decay of about 1,000 times that quantity of original matter. In preparing a field for planting, the dense natural growth of bush, or *chaparral*, is first cleared away, and this is done by cutting and burning, the cutting being effected by the blacks, with heavy, long-bladed knives, called "machetes." The plants are then set out about two feet apart, when they take root, and grow very quickly, great care being taken to keep down the weeds. The fruit comes to maturity in from eight to nine months, at which time the main stalk dies, leaving an abundance of young sprouts, which in turn spring up and bear fruit. The bush or plant upon which the pine-apple grows, is at maturity about thirty inches high, having long, slender, hard, blade-shaped leaves, with serrated edges. The leaves bend outward from the centre, and out of this centre the fruit springs, one pine-apple only to each plant. An acre of good land will easily support 6,000 plants of the sugar-loaf variety, or about 5,000 of the scarlet kind, and there is a large quantity of land in the Bahamas eminently adapted for the purposes of growing pine-apples which has never yet been cultivated. The price of good land varies between £1 and £4 per acre, and depends upon the size, the fertility of the soil, and its proximity to a suitable place for shipping the fruit; and as much of the fruit is taken on board vessels which call along the coast during the season, a plantation which borders upon some cove, bay, or good anchorage, is a valuable one. The average life of the scarlet pine is three years, and that of the sugar-loaf about five. The average weight of the fruit in the Bahamas is from three to three and a half pounds. A field is generally gone over three times during the season, affording three grades of fruit, called first, second, and third cuttings. The scarlet variety ripens a month or two earlier than the sugar-loaf. Owing to the sharp serrated leaves of the plant, the gathering of the fruit is a tedious and difficult matter, the men, women, and children engaged in the work being obliged to wear heavy canvas leggings and gloves with gauntlets to protect themselves against the sharp spikes of the plant. The pine-apple plants furnish but one regular crop during the year, although the local markets are seldom without pine-apples for sale. The first cuttings of the scarlet pines are made about the middle of April, and the last is made about the 1st of July. The sugar-loaf pine is at maturity during July and August. The shipping season is one of great activity in the Bahamas, as when the fruit is ready for the knife, it must be cut and hurried with all speed to market, or it will be lost. It is estimated that from seventy-five to one hundred cargoes of fruit are shipped from April 15th to July 15th, and about 40,000 pine-apples make an average cargo, the total exports reaching from 4,000,000 to 5,000,000 pine-apples during the season. The fruit for shipment is never allowed to ripen, but is cut when green, as soon as it is full of juice, otherwise it would spoil before reaching a market. The average price paid for the fruit is about 1s. 9d. per dozen for first cuttings, 1s. 6d. for seconds, and 1s. 3d. for thirds. Some growers export their own fruit, others sell to local buyers who purchase the crops at the foregoing figures. The pine-apple business, though a lucrative one, is very hazardous; if everything is favourable good profits are realised, but a few untoward circumstances will bring ruin. Occasionally there is too much rain or there is drought; at times armies of rats and land crabs invade and devour whole fields; and, again, bush fires frequently devastate a plantation. As a rule, the scarlet pine-apple is consigned to the United States, the sugar-loaf goes to England. As the latter voyage is a long one, the pine-apple plant is cut off at the root, and plant and fruit are shipped unseparated. The whole of the pine-apple crop is not now exported, a portion being put up or preserved in tin cans, several factories upon the islands being engaged in this work; at one alone, in Nassau, it is estimated that about 25,000 pine-apples per diem are consumed, and 200,000 to 250,000 cans of fruit are put up during the season. The wages paid to the workmen are at the rate of about 2s. a day for men, 1s. for women, and 6d. for children, and even lower wages are paid to plantation hands. For several years prior to 1880 the pine-apple industry was unprofitable to the colonists, owing to a succession of disasters in the way of bad weather, low prices, and decay; but during 1880 and 1881 good crops were made, better prices prevailed, and business materially revived. In 1880, about 340,000 dozen pine-apples were exported; in 1881, about 363,000. There were also shipped about 200,000 tins of preserved pine-apples; in 1880 and in the following year this number was increased to 287,000 tins.

ARROWROOT MANUFACTURE IN QUEENSLAND.*

The machinery used for the manufacture of arrowroot is simple in the extreme, and is chiefly manufactured on the place, the shafts, pulleys, and engine work being, of course, foundry made. The first process shown was the roots being tipped, by two boys, into a long trough, through the length of which a shaft slowly revolved, and by means of wooden projecting pegs, the dirty roots were stirred up, and so cleaned, there being a constant stream of water running through the trough. These revolving pegs have a screw pitch, so that the roots are gradually moved towards the far end of the trough, where they are caught up by a sort of bucket pump, which elevates them some 12 feet, and drops them regularly into a hopper. As they fall to the bottom of this, they meet the grater, which is a drum of perforated galvanised iron, driven at great velocity. A small stream of water pours into this all the time, and the roots are quickly grated up into a brown-coloured pulp. This mass of fibre and pulp falls into a cylinder of perforated iron, about 9 feet long, and 2 feet in diameter; through the length of this runs an axle, on which are two beaters, like the drum of a threshing machine; these smash up the fibrous pulp, exposing it to the action of the water, so as to enable all the starch and fine pulp to be washed out and squeezed through the perforations of the cylinder, while from the one end is discharged a constant stream of the dirty looking fibrous refuse. The finer pulp, as squeezed through the perforations of this cylinder, is received in a precisely similar one below; here, again, the mass, now only pulp, is beaten up; but the perforations around this second drum being very small, only the starch and dirty-looking water passes through, the pulp being again discharged from the cloaca at the end. The stream of water and starch pouring from these cylinders is received in troughing, extending for 100 feet around the shed, and, as it runs along, the starch being heavier than the water, all sinks to the bottom, and the water runs away. So far the work goes on automatically, no one but the two boys throwing in the roots troubling themselves about it. But towards the end of the day, the stream of water is stopped, and the arrowroot starch scraped up out of the trough, where it has accumulated in a layer some inches in thickness, and is placed in large vats and tubs, all ranged in regular rows. Before being put into these tubs, it is passed through fine muslin sieves, and at the same time another stream of water is turned on. These fine sieves effectually clear it of any foreign matter, and it settles by the morning at the bottom of the vats, clean and white as snow. The water is drained from it, and the starch put into a centrifugal machine similar to what is used for sugar; this soon forces out the surplus water, but perfect dryness is essential to its keeping qualities, so it is now carried to the drying-room, which is some 60 feet long, by 12 feet wide. Round the whole length of this runs a flue, heated by a special furnace, and over this are shelves of galvanised wire-netting; on this netting is placed calico, and on this is spread out the starch. In this hothouse the moisture is quickly evaporated, and the arrowroot becomes crisp and grain-like. On fine days it is spread out in the sun on similar wire stages. All operations are now finished, and the flour is stowed away in bins in the storehouse, and there made up into the packets usually seen in the shops.

Notes on Books.

THE A. B. C. OF MODERN PHOTOGRAPHY. By W. K. Burton. London: Piper and Carter. 1882.

This little book is a reprint of a series of articles in the *Photographic News*, by Mr. Burton, whose paper read before the Society last Session, will be remembered by those who take an interest in photography. The recent advances which photography has made, have brought within its powers results which a few years ago were unattainable; and it is not one of the least remarkable points about the progress of the science, that it has rendered the production of these results comparatively easy. The would-be photographer can have the first and most difficult of his processes done for him. He can purchase his plates ready-made, and if he will only attend carefully to the directions which accompany his purchase, he can hardly fail, even at a first attempt, to produce something more or less resembling a picture. An amateur, at the end of his first season, has even been known to boast that his first attempt was quite as good as any of his later efforts—and perhaps it was. This facility in picture-making is raising up a host of amateurs, who may be expected to be anxious to acquiring a mastery of their art with the smallest expenditure of time and trouble. For these Mr. Burton writes. He assumes no previous knowledge. He begins at the beginning, giving minute and detailed instructions for every stage of the process, from the time when the plate is placed in the dark slide to the completion of a print from the finished negative. The little book only deals with the gelatine process, but to the extent to which it goes, it is complete, and so far as manipulation can be taught by written instructions, it is taught. In spite of the simplicity of the processes to be carried out, the learner will, doubtless, soon discover that there is abundant scope for dexterity in manipulation as well as for judgment. That this is so, is sufficiently evident from the different degrees of excellence to be observed in the productions of our best photographers—professional and amateur; and it will be found that while, thanks to the manufacturers of apparatus and gelatine plates, a certain low standard of excellence is rapidly attained, to pass beyond this level is far from easy. Were it not so, the only interest left for the photographer would be the arrangement and treatment of his his subject, so that his pictures may really be pictures, and not mere transcripts of the scene towards which his camera happens to be pointed. Artistic merit will always be the quality most sought, but there is still room for many different degrees of technical excellence.

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* From the *Queenslander*. Reprinted from the *Pharmaceutical Journal*.

THE WATCHMAKERS' HAND-BOOK. By Claudius Saunier. Translated by Julien Tripplin and Edward Rigg, M.A. London: J. Tripplin.

This book may be considered as a supplement to the more elaborate work on "Modern Horology," by the same author and translators. It seems intended to supply practically all the information likely to be useful to a watchmaker, and will doubtless be found serviceable also to others engaged in the more delicate mechanical arts besides watchmaking. The first part treats of arithmetic, geometry, and measurement, describing the various drawing and measuring instruments, as well as giving a little elementary arithmetic. Part II. treats of the materials employed in Horology, their preparation, treatment, and application. Part III. discusses the apparently incongruous topics of "Health and Manipulation," the latter portion of the division being devoted to instructions in the use of the file and graver, while the first portion is principally devoted to the preservation of the sight. Part IV. gives an account of the various tools and appliances used by watchmakers. Part V. is more special, and gives instructions for repairing and examining watches, and Part VI. contains a number of practical receipts.

General Notes.

INSTITUTE OF PATENT AGENTS.—An Institute of Patent Agents has been incorporated, with the object, as stated in the articles of association, of promoting improvements in the Patent-laws, framing rules for patent practice, and generally, as it would appear, for raising the status of patent agents. The list of the first council includes the names of the principal patent agents. Mr. G. G. M. Hardingham is the secretary.

TEXTILE INDUSTRY OF ALSACE.—The Chamber of Commerce, at Colmar (Alsace), has recently issued a report, according to which there are in the district 97 weaving mills containing 17,003 looms, and 38 spinning mills, with upwards of 700,000 spindles. Out of the latter 31 work with water-power as well as steam, only 7 of the establishments having steam as their exclusive motive force. Of the 97 weaving mills, 11 are worked by steam alone, and 51 by water-power as well as steam. Water-power is also in general use in connection with the bleaching industry of the district.

HAY AND CORN DRYING COMPETITIONS.—The judges appointed by the Royal Agricultural Society to test the merits of the different appliances adopted by the competitors for a prize of 100 guineas offered for the most efficient and economical method of drying hay or corn crops artificially, either before or after being stacked, have now made their report. There were eight competitors, six of whom employed the "Neilson" system of exhaust fans for drying in the stack; the two remaining competitors using, in one case, hot air applied before stacking, and in the other a system of ventilation assisted by hot air applied after stacking. All the inventions were tried on hay, but a selected three out of the various adaptations of Neilson's system were submitted to an extended trial both on hay and barley. In the end, however, none of the exhibitors proved that they were able to make good hay in wet weather. In a few instances where fairly good hay was obtained, equally good, if not better, might have been secured without the application of fans. The trials of the three selected fans upon corn were even less satisfactory than those upon hay, none of the machines having succeeded in effectually drying the corn in the stack. Under these circumstances the judges report that they do not feel justified in awarding the prize.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

*GAS BURNERS.**

By William Sugg, A.I.C.E.

Coal gas, as now supplied to the public, consists of hydrogen and marsh gas to the extent of about 80 per cent., and the remainder consists of luminous hydro-carbons of various qualities, with traces of sulphur in the form of disulphide.

The gas supply of London is watched over by a Commission, appointed by the Board of Trade, called gas referees, who are Professor Tyndall, Professor Vernon Harcourt, and Mr. Pole. They are empowered to prescribe the manner of verifying the illuminating power and purity of the gas, and they have also authority to act in cases of dispute in public lighting. Their prescriptions, as emanating from the only legal body of the kind in the Kingdom, are accepted as the proper methods, so that in effect, though they are appointed in London, they may be said to be gas referees for the whole kingdom. But the use that is made of gas is a matter which is altogether out of the control of gas companies and their engineers, and here the proverb about food and bad cooks may be paraphrased. The great hindrance to the improvements in the use of gas has been the general public themselves, who have not taken sufficient interest in the kinds of apparatus employed, but have, as a rule, supplied themselves with the cheapest burners, stoves, and other apparatus, utterly regardless of the waste and annoyance which this system entailed; and when they have complained, they have always attributed the causes of failure to the quality or pressure of the gas, instead of ascribing it to the true cause.

In 1871, the gas referees made an examination of a number of gas-burners which they had collected from various large establishments, newspaper offices, warehouses, shops, and dwelling-houses, and they found that those burners (samples of those generally employed by the public) would only give about one-half the light that the gas was capable of yielding per cubic foot consumed, and several of the burners tested by them gave only one-fourth of the proper light of the gas.

They say in their report to Parliament:—"The economy to the public, arising from the use of good gas-burners instead of bad ones, is so obvious as hardly to need remark. The gas-rental of London amounts annually to more than two millions sterling Taking a very moderate estimate, upwards of one-fourth of this sum (£500,000 per annum) might be saved by the use of good burners. This is the saving which might be made in London alone; how much vaster the sum thus economised if good gas-burners were to come into general use throughout England."

Now, the quantity of gas used in London last year, according to the analysis of the London Gas Companies' accounts, prepared by Mr. John Field, was, in round numbers, 20,230,000,000 cubic feet, which is equal to a bulk of one mile square × 726 feet high, and its cost to the public was £2,911,000.

The result of careful trials, made with a number of burners taken lately from private houses and shops, shows that, as a rule, the amount of light obtained by the general public, from five cubic feet of gas, is less than one half of that which it is capable of giving. The iron and metal burners, of which a great many are used, give the best result in light when they are worn out, although the shape of the flame is bad. The reason why, is that in order to obtain from what is a compound of hydrogen, marsh gas, and carbon, its best effect in light, the burner must be so made that the quantity of gas required to be consumed is proportionate to the size of the burner, so that it cannot exceed the maximum quantity which the burner is made for. Then the outlet of the burner itself, whether it be of the Argand or the flat-flame form, must be so arranged that the gas issues forth at a sufficiently low rate of velocity, so that it has time to get to get heated to a proper degree by the hydrogen and marsh gas before it comes into combustion with the oxygen of the atmosphere. When this rate of velocity is obtained in an Argand burner, the pressure at the point of ignition is almost *nil.* In flat-flame burners the pressure of the gas must be raised to a point sufficient to blow out the flame to a fan-like shape, but it must only be sufficient to do this if it is desired to obtain a good result per cubic foot of gas consumed.

One more point is of great importance in the construction of a gas-burner—that is, that the gas should not be heated until it arrives at the point of ignition. The body of the chamber below the point of ignition must therefore be made of material which is a bad conductor of heat; so as not only to prevent the undue expansion of the gas before it arrives at the point of ignition, but also to maintain the heat in the flame.

Sir Frederick Bramwell very ingeniously pointed out, some time since, that the important point in the proper combustion of gas is not so much to keep the gas cool as to keep the flame hot. The distinction is extremely subtle; but, nevertheless, a non-conducting gas-chamber performs both these important functions. If a gas-chamber made of metal or any good conductor of heat is used, then the gas becomes expanded in bulk, and the velocity of the issuing gas is greatly increased; less time being given for chemical combinations necessary to produce a proper amount of light from it. In addition to this, as Sir Frederick Bramwell has pointed out, the heat which should remain in the flame is conducted away from it into the lower fittings of the burner, where it may burn the fingers of the incautious consumer, but it is of no manner of use in the evolution of light.

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* Abstracted from a paper read before the Mechanical Section of the British Association, at Southampton.

You will, perhaps, say it is not possible to conceive how the flame can be kept hot without keeping the gas cool at the same time, because if the heat is to be kept in the flame, and not conducted away down the stem of the burner, the gas must be kept cool by the means employed. But, nevertheless, there is a difference in the effects produced, and the ingenious definition of Sir Frederick is scientifically accurate. As an explanation of the expansion theory, it may be stated that if one cubic foot of gas is heated to about 500° Fahr., it will occupy the same bulk that two cubic feet do at the mean temperature of the atmosphere. Now, supposing it is issuing in a cool state from the aperture of the burner at a velocity equal to one and a-half miles per hour, it must then issue at the rate of three miles per hour, if the rate of consumption is equal in both cases. Therefore it has only half the time in the heated state to combine with the oxygen of the air that it had in the cooler state, and a loss of illuminating power is the result. Again, as regards the maintenance of the heat in the flame; supposing the chamber from which the gas issues is a conductor of heat. In this case the heat from the flame is conducted away from it down the stem of the burner, expanding the gas and leaving the flame so relatively cooled, as to require more gas to raise it to the necessary state of incandescence to allow the oxygen to combine with it in the proper proportions. In this case, as the two operations are simultaneous, it is difficult to apportion the effect produced. But that the effect is produced is proved by the following experiments, made some ime since by the late Mr. F. J. Evans.

Two Argand burners were made precisely alike in every respect, except that one had a combustion chamber made in steatite, and the other in brass. The same quantity of gas was consumed through both of these, the result being that the burner with the non-conducting chamber gave more light per five cubic feet of gas consumed than the other, the proportion being as fifteen candles to thirteen. The burner with a non-conducting chamber was quite cool immediately below the chamber, while the other was so hot that it could not be touched without burning the hand. The metal burners which are now used in enormous quantities in London and the provinces become exceedingly hot, so much so as to communicate the heat to a considerable distance down the fittings. The velocity of the issue of five cubic feet per hour of gas from these burners, varies from ten to sixty miles an hour. The worn-out burners generally give the lowest velocity. As a rule, the metal burners give the lowest result in light per cubic foot of gas consumed.

For example, a metal burner of the flat-flame type, which has been stated in the columns of the *Journal of Gas Lighting* to be identical with the steatite hollow-top burner, invented in 1868, gives the following results:—A large-sized burner, No. 8, burning five cubic feet per hour, gave a result equal to 11·5 candles, whilst the result obtained with a like quantity of gas from a steatite burner of corresponding size, which has a non-conducting gas-chamber, was 14·6 candles, a difference in favour of the steatite of 3·1 candles, or nearly 25 per cent. more light. Another metal burner, of a size more generally in use by the public, only gave 6·2 candles for the five cubic feet, or considerably less than half the latent value of the gas, which was 16 candles.

The fact of the difference of illuminating power, with like quantities of gas, clearly shows that the two burners are not the same by any means. The statement gravely made in the columns of the *Journal of Gas Lighting* that they are identically the same, clearly shows that if this is the belief of the gas trade generally with respect to these two burners, it is no wonder that the public, who rely on the recommendations of the trade, continue still to waste their gas in the manner pointed out by the gas referees in 1870 and 1871.

As before stated, careful tests of a collection of burners, bought from different gas-fitters and ironmongers in various towns in England, and from their recommendation, prove that the knowledge of the proper use of gas possessed by these persons is still most incomplete, and, therefore, the general public continue still to burn gas in the same wasteful manner as they did when the gas referees made their report.

The remedy for this enormous waste of gas is in the hands of the public only. Gas producers, whether thev are corporate bodies or public companies, are almost powerless to oppose the vested interest which derives large profits from the sale of gas-burners constructed with a view to require frequent renewals. It is only fair to say that the producers of gas have always shown the greatest interest in the improved use of gas in every way; but the speculating builder and his colleague, the local plumber and gas-fitter, hold a final power for evil over the employment of gas, which, till very lately, has been paramount.

Happily for the gas interest, the general public are beginning to take a deep interest in gas, and are acquiring a great amount of information concerning it, through the numerous gas exhibitions which have been held under the auspices of gas companies and corporate gas committees throughout the kingdom, and it is to be hoped that the forthcoming exhibition at the Crystal Palace, in October next, will very largely aid the good work of instructing the public how to use gas to the best advantage. Thus we may hope that soon the ring of interest inimical to the progress of gas will be broken through, and fresh encouragement given to the inventors of improvements in the use of gas. It will be impossible, in the limits of this paper, to give you a complete idea of all the improvements which have been, and are still being made; but I propose to indicate the direction they are taking, and give you a general idea of what they are.

It has been found that a comparatively large quantity of gas, about four to six times that ordinarily used, will give a much better result from one burner per cubic foot of gas consumed than can be obtained from four or six separate burners consuming the aggregate quantity of gas equal to that consumed by the large one; and this is true of both Argand and flat-flame burners. This is by no means a new idea; it was known to Faraday and others before him. I have in my possession an old burner made many years ago; it has several rings and a silver top drilled with very fine holes. The quantity of gas used is large—the effect is small—in fact, it is more useful for boiling water than for giving light. But this old burner is a type of a large Argands of twenty or thirty years ago. They did not succeed, because although they produce a great amount of light, it was at the cost of too much gas. Modern Argands will produce just double the amount of light for the same quantity of gas.

There is also incorporated in some of the newest burners now before the public an idea which was originated by Professor Frankland more than ten years ago, viz., that if the air for combustion supplied to a burner be heated before it arrives at the point of ignition, a much better result per cubic foot of gas consumed can be realised. This you will perceive is a mode of carrying out Sir Frederick Bramwell's idea of keeping the flame hot, and undoubtedly a better result can be obtained. This burner, although it did not come much into use, has very lately been repeated, and is now being sold on the Continent. The burner is so much like Dr. Frankland's that there is no difficulty in recognising it at once.

Of the modern Argands, there are now several kinds; one is made with two or three concentric rings of flame and a glass chimney, and is made with non-conducting steatite gas chambers, and apertures permitting the gas to issue under an almost inappreciable pressure at the point of ignition, the velocity per hour being only about 1½ miles. In this kind of burner the gas is kept cool and the flame hot. These were first used in the public lighting of Waterloo-road, in 1879, and in Waterloo-place and Queen Victoria-street.

Another kind, of newer type, is made on the theory of keeping the flame hot by making use of the products of combustion to heat the air-supply. This also combines the low velocity of emission theory, and likewise heats the gas itself. It is made by inverting the flame of the burner, the heat generated by the products of combustion being carried away by a concentric flue, fastened round the burner, through which metallic tubes convey the air necessary to produce combustion, which thus becomes heated.

A third is constructed on the principle of keeping the flame hot and the gas cool, but has besides an arrangement for admitting separate currents of cold air round the flame, for the purpose of keeping the chimney cool. It was important to observe that, although this burner does not warm the air admitted to it for promoting combustion, yet the results per cubic foot of gas consumed are stated to be as high as any of the others, showing clearly that there is no advantage in heating the gas before combustion. As to the advantage obtained by heating the air, the practical effect upon an Argand suitable for use by such ordinary unskilled labour as it usually employed to look after gaslights, has not yet been clearly demonstrated; although it is without doubt a great advantage to burners of the flat-flame type, because these have always too much cold air supplied to them.

The Argand, with its more complete regulation of air and its immunity from the effect of surrounding cold air, is able to evolve from 15 to 30 per cent. more light per cubic foot of gas consumed than can be obtained from the best flat-flame burner; but, although the general public have no objection to glass chimneys in paraffin and other oil lamps, they do not appear to look with favour upon the general employment of glass chimneys for gas-burners, no matter how much better the result to be obtained. I need not say that the cordial support of the ring inimical to the true interests of gas is given to the public on this point, and a great deal of very strong literature condemnatory of the Argand burners has been widely disseminated. But it is impossible, in the face of the improvements which are continually being made in gas-burners of the Argand type, to believe otherwise than that they are destined to play an important part in the gas-lighting arrangements of the future. The improvements in the flat-flame burners, though not producing such high results as those obtained from large Argands, are great, and, concurrently with improved lanterns, have placed the lighting of the public streets on a much improved footing. Here, again, about three times the amount of light per cubic foot of gas is obtained from the use of large burners than with the old-fashioned small ones. The consumption of gas by the large ones is only equal to the aggregate consumption of four or six smaller burners. In addition to this, the improvements in the reflecting tops of the lanterns make the new lamps still more effective, and may fairly be said to double the effective power. In internal lighting, the progress of gas has been very considerable of late years. Small burners for rooms have been greatly improved. For large rooms and theatres new kinds of sun-burners are made, to give three times the amount of light obtainable from the old ones, and to ventilate the buildings at the same time.

One of the greatest advantages of gas is that the heat generated by the combustion can, if properly applied, be made to do the work of ventilation, and it is in this direction that the future progress of gas lighting lies. There are many ways of utilising this heat; some are extremely easy to put into practice, others require more preparation. Among the simplest, is the method of ventilating rooms by the fish-gill ventilator, invented by the late Goldsworthy Gurney. It consists simply in covering an opening made in the wall with strips of calico fastened across the hole by tacks put into the two upper corners of each band. The bands are made just long enough for the lower part of the superior band to cover the top part of the inferior one. When fixed properly, they open like the gill of a fish, hence the name. They can be used to let in fresh air, or carry off heated air from the top of a room.

These useful and simple ventilators, if employed in rooms where gas is used, would tend greatly to the comfort of the public who require a good light, but complain of the resulting heat. They work when closed by diffusion, the heated air passing through the porous medium of the calico, and the cooler air from outside the rooms passing in without draught. For the ventilation of ball-rooms it is very easy to put into the windows a frame fitted with muslin or washed calico of half or even the full size of the window. Ventilation will thus take place by diffusion, and the draughts and danger resulting from incautiously-opened windows will be avoided. If the wind blows hard on this opening, it may be protected by a loose curtain of muslin or calico hanging in front of it.

You will perceive, therefore, from what I have said, that the progress of invention in gas lighting is great and continuous, and that in the future, if the public will only interest themselves just sufficiently to obtain a moderate amount of information on the subject of gas, they will be enabled to use it with great economy and comfort to themselves in every way. The facile manner in which gas can be employed to produce the light of a rushlight or the blaze of a thousand candles by the mere turn of the wrist, joined to the readiness with which it can be conveyed to great distances without any practical loss, will always ensure a large and growing demand for it everywhere.

But it must be remembered that its extreme adaptability renders it capable of being used with the most crude apparatus as well as the most perfect; and when we see in the public streets the blazing pipe and shovel, a rough but powerful burner of from 100 to 600 candles power, rigged up in a few minutes by a navvy, we must not be surprised at the prevalence of crude apparatus of smaller dimensions put into practice by the public, who are not aware that they can do better with a more perfect burner.

OUR SUPPLIES OF IVORY.

By P. L. Simmonds.

There has been an outcry and discussion of late as to failing supplies of ivory, and the probability of a dearth of this valuable raw material; but at present there would appear to be little foundation for this fear, whatever there may be in the future.

Considering the animals from which it is derived, it is remarkable how comparatively regular and uniform has been the annual supply of this precious commodity, which it has hitherto been found impossible to replace satisfactorily by any artificial substitute. It is difficult, perhaps, for the ordinary dealer to arrive at any correct data to guide him in his purchases, for the official trade returns are not very clear, and he must consult a good many documents, home, Indian, and colonial, in order to get at the facts, and arrive at any correct conclusions. In the monthly Board of Trade returns, instead of having the heading ivory to turn to, he must refer to "teeth," where are mixed up tusks of the elephant, with canines of the walrus, hippopotamus, and others, which might all well be commercially classed as ivory, even if they are not pure decussated dentine.

As the wholesale import trade in ivory rests in a few hands, and London is the great mart, there may be policy on the part of the importers in holding back stock occasionally from the public sales, in order to enhance prices. If the subject be looked at seriously and steadily, there would appear to be no reason for any panic or undue advance in prices. There is, doubtless, a steadily increasing demand on the part of manufacturers in Europe, America, and Asia for this animal substance, but the official figures do not show any important decline in the supply of either African or Indian ivory, though small fluctuations year by year there necessarily will be in an article drawn from distant sources. We are not yet able to produce ivory in quantity in domestication, as we have done the equally valuable ostrich feather, but a passable substitute, for some of its uses has been found in celluloid. In domestication, too, the length and quality of the tusks of the elephant are usually found to deteriorate.

Our total imports of ivory in the three last periods of five years respectively, were as follows:—

	Total. cwts.	Annual average. cwts.
1870	59,423	11,884
1875	67,034	13,406
1880	62,484	12,496

The supply of Asiatic ivory has not fallen off, for, in the five years ending 1880, our total imports were 18,419 cwts., giving an annual average of 3,684 cwts. The imports of the previous five years were only 9,346 cwts., an average of less 1,900 cwt. per annum. The highest import from the East in any one year was 5,000 cwts., in 1858. But it must be borne in mind that there is a large local demand for manufacturers in China, Japan, India, and Ceylon. The imports of ivory into India in the three years ending respectively with 1st April, were in 1880, 431,740 lbs.; 1881, 471,689 lbs.; and 1882, 511,829 lbs., of this about half was re-shipped.

From the Cape Colony the exports have nearly doubled in quantity in the last ten years; in 1878, 149,701 lbs. were shipped. From Natal, owing to various causes, the exports have fluctuated from 50,000 lbs. in 1870, to 37,000 in 1878. The supplies from Lagos have also dropped to a mere trifle of 1,000 lbs.

The following table shows the principal quarters from which our supplies are drawn, Africa being still the chief source:—

	1870.	1875.	1880.
Egypt	4,521	2,411	2,003
South Africa	1,185	1,442	1,114
British West Africa	....	251	162
West Africa, not designated	1,322	2,297	2,310
Portuguese Possessions	410	312	361
East Coast of Africa	....	696	1,099
British India	221	3,560	3,665
Other Countries	4,631	5,289	2,721
Total	12,590	16,258	13,435

The officially-returned imports of ivory into the United Kingdom have been as follows:—

	cwts.	Re-exported. cwts.
1840	5,469	not known
1850	9,396	,,
1860	10,854	,,
1870	12,590	4,039
1875	16,258	7,564
1880	13,435	7,967

It will thus be seen that we retain nearly one-half of what is received for manufacturing at home.

Those who are interested in the ivory trade and its applications, will find long and elaborate descriptions in a paper of mine in the *Art Journal* for 1874, p. 120; in my work on "Animal Products," p. 328; and in a paper read before the Society of Arts by Professor Owen, on the 17th December, 1856.

MUSICAL INSTRUMENTS OF THE JAVANESE.

An opportunity has occurred for adding somewhat to our knowledge of Javanese music. Some Dutch gentlemen have just brought to Europe a troupe of Javanese dramatic performers, with their musical instruments. They came from Batavia to London, and their first performances are being given in the annexe of the Royal Aquarium. Hitherto, all we have known either of the music of the Javanese or of their musical instruments, has been from Sir Sir Stamford Raffles' "History of Java," published in 1828. In the midst of his political duties he found time to examine the antiquities, the literature and the classic language (the Kawi), and, to some extent, the traditional music of the Javanese. Humboldt far more exhaustively studied the language, and the results of his work occupy three large volumes of the Transactions of the Berlin Academy.

Dr. Caldwell, in his work on the Dravidian languages, has pointed out the probable relative place of Kawi among other languages. Only small portions of the old poems written in it have been rendered into modern language, though it continues to be the language of the drama. A few travellers have described some of the antiquities, but the information about the music of this people has remained most scanty, though the few details given by Sir Stamford Raffles shows there is a high interest attached to it.

Although the Javanese now survive only in the two small provinces of Djojckarta and Sovrakarta (or Solo), and the hereditary princes are little more than nominal rulers under Dutch protection, the Imperial gamelans are sedulously retained as part of the Court appendages, and musical entertainments continue to have a firm hold on the interest of the people.

It is not quite clear how the word gamelan is exactly used. Some recent travellers speak of a gamelan for a pleasure party which consisted only or three instruments, though a Court gamelan is said to number over a hundred. Some apply it to the instruments only, and others again under the term seem to include the dramatic performers. Our word orchestra (as used to include band and chorus), would, perhaps, be the nearest equivalent for a full gamelan, as there are vocal parts assigned to female voices, which are given by performers who remain seated on the ground, to distinguish them from the actors. Sir Stamford Raffles speaks of gamelans for festive processions and for military music. There are also gamelans of bamboo instruments entirely, and apparently sometimes tom-toms and flutes only are used.

The instruments these Javanese have brought are only such as are used for dramatic performances, and it is these only which are here described. Although the announcements speak of the Javanese gamelan, it is clear there are two quite distinct sets of instruments, which represent different musical systems. Interspersed as they stand among one another, and many of them similar in appearance, this was not readily apparent, but after comparing the notes of the instruments separately, it is certain that one system is pentatonic (like the old Scotch scale), and the other contains intervals which cannot be referred, with exactness, to any in our system. Except the rebab and soeling, all the instruments are percussive, and the uncertainty of determining some of the notes is no doubt partly due to want of that practical skill in striking them which is necessary for producing the clearest tones. Several of the instruments, however, are in duplicate, and no amount of variation in the manner of striking seems to get some of the corresponding duplicate notes exactly alike. Great allowance must evidently be made for these instruments being imperfectly tuned. The pentatonic system is unmistakable, and where a note is not exactly in tune, it is easy to know how far it is wrong. The other system is somewhat a puzzle. Assuming the notes to be true, there are in some cases, five intervals to one of our intervals; in other cases, the interval is the same, while some of our notes are altogether wanting. The native name for the gamelan of instruments with the pentatonic scale is *Gamelan Salindro.* The other is called *Gamelan Pelog.* The only instruments common to the two are the trio-stringed rhebab, the drums and the gongs. There are other instruments similar in construction in both gamelans, the only difference being the difference in their scale. All the percussion instruments may be grouped under the types, harmonicon, bell, gong, drum, Ketzer (?) They are all played with *topoos*, which may be roughly described as drumsticks, though there is a great variety in their shape and wadding. The following are their names and description.

Harmonicon Type (Wood Plates.)

Kambang.—The sounding plates are of wood (stated to be a species of pyrus), which rest on a carved and painted frame, about ten inches high. The plates are kept in their places by metal pegs driven into the frames. They are not fixed, but at one end there is a hole through which a peg can freely pass, and the other end lies between two pegs. Their position can be thus easily changed. The tapoos with which it is played are in shape like those used in a British cavalry band, with the rim covered with prepared woolly skin.

The *Kambang Salindro* has twenty notes, with a range of four octaves. The lowest is 24 in. long, and the highest about 12 in. long. The length of the frame is 4 ft. 3 in.

The *Kambang Pelog* has nineteen notes. The lowest is about 24 in. long, and the highest 12½ in. long. The length of the frame is 4 ft. 4½ in.

Harmonicon Type (Metal Plates).

Saron.—The sounding-plates or bars are of metal, stated to be an alloy of copper and silver, and without any tin. Those of the lower notes are so thin in relation to their size, they can be best described as plates, but in the ascending scale they are gradually more bar shaped, till for the highest the bar is arch shaped, in transverse section, with a depth about equal to the width at the base. In the sarons of the *Gamelan Salindro*, the notes are in groups of six for each instrument, each being a complete octave interval, and the sarons in sequence range over three octaves, with the pentatonic intervals. The highest is called *Saron peking salindro*, the next *Saron allete salindro*, and the lowest the *Saron demong salindro.*

For the *Gamelan Pelog* there are similarly three sarons, but in groups of seven notes each. The intervals are, of course, different from the salindro sarons, the second and sixth being octaves. The adjectival names, peking, allete, and demong, are similarly used for them.

The sarons are played with tapoos; those for the demongs are padded, those for the alletes and pekings are mallet-shaped, and of hard wood.

Slentem salindro.—The *Slentem salindro* is an instrument which follows in sequence the octave next below the *Saron demong salindro.* The only essential difference is that each plate has a hollow boss.

Bell Type.

The word *Bells* is here used for the metal instruments, which have a shape like an inverted kettle with a hollow boss on the top. There does not seem to be any native generic name for them, and no European writer appears (so far as can be told from researches at the British Museum) to have described them. Bells, in the ordinary acceptation of the word, are hung, and are struck not far above the rim; these are not hung, but rest upon two stretched cords, and are struck on the top of the boss. The difference in the way in which they are supported, so as to vibrate in response to a blow, does not seem to warrant the introduction of a new name. The presence of the hollow boss is distinctive, and may perhaps, when its effect on overtones is more accurately studied, require the use of some convenient term, such perhaps as "boss-bell," but in this description they are called simply "Bells."

There is a great range in the relation of the various dimensions. The diameter of the bell at the mouth varies from seven inches to eighteen, the sides are from four and a half to eight inches. The boss is from three to five inches across, and from one inch and a half to three inches high.

All these bells stand separately. Bells of higher pitch are mounted in groups, each group having a strong wooden frame. Only those which stand singly have separate names. The groups are regarded as separate instruments. The slentem pelog consists of a group of seven bells, the bonang pelog of fourteen bells, and the deneros (also used in the gamelan pelog above) of fourteen bells. The two groups have "bosses" in the middle, but this is common to some Chinese gongs. There is nothing distinctive in the drums, tom-toms, flute, or rhebab. It is the metal instruments that are most interesting. Many of the plates and bars are attractive by the beauty of their tone, but the bells are more than this.

There are many subjects for study in these unfamiliar instruments which may, perhaps, furnish practical hints to bell founders. A question by no means easy to answer is, what relation is aimed at between the "boss" and the rest of the bell. The mode of manufacture is stated to be, that the metal is first roughly cast in a mould, then hammered into shape, and then the note is brought to the desired pitch by filing. What is aimed at and what is actually done are evidently different, unless an approximation satisfies. The bosses are, in some cases, far from central, and the diameters of some of the bells, taken in different directions, varies as much as half-an-inch. It seems as if the intention were to make the boss give an octave of the entire bell, but in some cases the fifth or twelfth is predominant. A satisfactory study of them could be made only in some quieter place, and it would be well if this could be done before they leave London. As regards the combination of the instruments as a gamelan, it will be seen that practically there are but three instruments; the series of plates and bells giving the different octaves of one instrument, the kambang in itself forming the second, and the drums the third. The drums seem to be equivalent not only to drums as commonly used, but to sound sustaining stringed instruments, as when they are played with a rapid succession of taps.

Writers on oriental music have probably dwelt too much on the peculiarity of scales, for in the case of these Javanese instruments, notes in sequence seem never used.

SECONDARY BATTERIES.*

By Dr. J. H. Gladstone, F.R.S.

The elements of which a Planté battery and its curious modifications consist are metallic lead, peroxide of lead, and dilute sulphuric acid. The reaction that takes place is the combination of the positive metal with SO_4, forming PbSo (plumbic sulphate), and the reduction of the PbO_2 (peroxide of lead) by means of the hydrogen of the sulphuric acid to PbO (plumbic monoxide), which, in the presence of sulphuric acid, is also converted into sulphate of lead and water. The amount of force which can be obtained from a cell depends upon the amount of peroxide of lead which is capable of being reduced. Now, the negative plate of these secondary batteries is itself an arrangement of lead and lead peroxide, and if immersed in dilute sulphuric acid, galvanic action is at once set up. The "local action" is, fortunately, soon diminished by the badly conducting sulphate of lead upon the surfaces of the lead plate and crystals of peroxide. When the two plates are brought into connexion, the discharge takes place between them, but the local action on the negative plate is not stopped. This is shown by the much larger amount of sulphate of lead produced on the negative than on the positive plate. In experiments quoted by the author this increase amounted, in one instance, to 53 per cent. The amount of available peroxide of lead that may be thus destroyed on any negative plate is not easily recognised, for the electromotive force is not affected, and the current attainable in the first instance is not much reduced, though of course the same amount of work cannot be got out of the battery. This local action takes place also during the formation of a cell. One of the proofs of this is that much more oxygen is absorbed than could possibly be absorbed in the oxidation of the minium used in a Faure cell; indeed, in one experiment which was continued for 115 hours, it was found that a small amount of oxygen was being continuously absorbed, though the main action was complete in less than forty hours. This was attributed to the formation of sulphate of lead at the expense of the lead plate, and its subsequent oxidation. As this local action impairs the value of these secondary batteries, it becomes an important problem to ascertain what modification of the present arrangements will minimise, if not entirely prevent it.

THE PETROLEUM WELLS OF TRANS-CAUCASIA.

Consul Peacock, in his last report on the trade and industries of Baku and Batoum, calls attention to the increased production of petroleum in the former district, and states that the total area of the Baku petroleum region, taking its extreme points of surface oil, gas wells, &c., is not less than 1,200 square miles; its elevation above the level of the Caspian Sea varies considerably. The Caspian is eighty-six feet below the level of the ocean. The general aspect of the petroleum region is that of a barren desert, deprived of water and vegetation, chequered here and there with dried up salt lakes, natural outflows and pools of oil, gas wells, and exhausted mud volcanoes. Even on the surface of the water of the Caspian, natural outflows of petroleum and gas may be seen at certain places. The boring operations are mostly carried on in the peninsula of Apsheron, where the potential productiveness is considered to be much greater than that of American petroleum regions. It may be justly stated, says Consul Peacock, comparing the results achieved in the two countries on the one hand, and the average depth and total number of the wells on the other, that the natural petroleum riches of Baku have no parallel in the world. The lands are partly purchased and partly held by lease. The former comprise about 1,836 acres, sold by the Crown to different persons, by public auction, for the sum of £300,000; for certain plots as much as £3,500 per acre has been paid. The yearly rent for leased Crown land is only about 7s. 6d. per acre. These lands were, some few years ago, supposed to be worthless, but the contrary has been proved since, and they now form a subject of wild speculation among the numerous leaseholders. A tract of the most valuable land, with an area of 270 acres, has been granted to a certain number of high officials, as a token of Imperial favour. In 1873, the number of wells sunk by way of drilling was 17. The total number now is about 375. The average depth of borings is 350 feet, and the deepest well 637 feet, with a diameter from 10 to 14 inches. The number of unproductive wells from natural causes is comparatively small, but a great many are abandoned for want of means or skill to continue the boring, or still more frequently on account of the extremely low price of crude petroleum. Flowing wells, yielding from 2,000 to 4,000 barrels (40 gallons to the barrel), and pumping wells, yielding from 300 to 600 barrels daily, are of common occurrence.

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* Abstract of paper "On Secondary Batteries, with Special Reference to Local Action," read before the Mathematical and Physical Section, Southampton meeting of the British Association.

Within the period of 59 years' monopoly—from 1813 to 1872—the maximum yearly production of crude petroleum never exceeded 212,000 barrels; in the first year of free competition it at once more than doubled, and the average production annually for 1879, 1880, and 1881, amounted to from 3,000,000 to 4,000,000 barrels, and besides this, immense quantities of crude petroleum are wasted at the place of production for want of adequate means of tankage and transportation. The extraction of petroleum for domestic use has been carried on by the natives from time immemorial. It became a resource of commerce about 1813, and formed a monopoly till 1872, when the system was finally done away with, an excise duty being imposed on refined petroleum, which, in its turn, was abolished in 1877; and it is since that period that the petroleum industry, being virtually thrown open to free competition, commenced to attract enterprise and capital on a scale unexampled in Russia.

Petroleum refineries have lately sprung up in great numbers, and there are, at the present time, 193 refineries, with 487 stills, of a daily working capacity of 300,000 gallons of refined petroleum. The price of kerosene at Baku, during the period from 1870 to 1879, has fluctuated between 1s. 8d. and 3d. per gallon. The different products derived from petroleum in their respective application for illuminating, heating, and lubricating purposes, have proved of immense importance as substitutes for other less abundant natural riches. In 1881, the petroleum products exported from Baku by sea, amounted to 2,946,000 barrels, and these included 1,450,000 barrels, or 58,000,000 gallons, of kerosene, the rest consisting of crude petroleum refuse and lubricating oil. Some works have lately been completed to facilitate the manipulation and marketing of the produce; a railway line, ten miles long, with tank cars, connects Balakhane, the principle group of wells, with Baku; the wells, refineries and piers are also connected by several pipe lines, their total length being about sixty miles. A large number of tank steamers, and several hundred sailing vessels, have also been built specially to carry the petroleum without casks. The Baku harbour has 25 piers, and some of them are furnished with pipes and pumps, so that tank vessels may be loaded at the rate of 100 tons per hour.

SILK-TESTING MACHINE.

Consul Peixotto, of Lyons, calls attention to a new silk-testing machine lately invented, called the "Serigraph Serrel," which has been for some little time in use both in France and Italy. The invention is said to be considered remarkable and ingenious by the silk experts of Lyons, as appears from a paper on the subject read before the Scientific Society of that town by M. Adrian Perret. The filature or reeling of silk comprises three operations, each requiring considerable skill and great care to produce good silk with the machinery at present in general use. In the final operation of reeling, the grège or raw silk is made, and this is the thread which is afterwards doubled and twisted to form the warps and woofs of silk goods, which, in the trade, are known as organzines and trams. The raw silk is an exceedingly fine thread, though it is formed of from four to ten or more separate filaments, each derived from a separate cocoon. To reel the silk, the cocoons are placed in hot water, and the filaments from several of them, being united by being pressed together, adhere to one another because of a natural gum with which they are covered, and which is softened by the hot water. The thread resulting from the union of these filaments (which is the raw silk) is then wound on a reel, the cocoons each paying out the filament until exhausted. The reeler's business is to form this thread of raw silk, and keep it as regular as possible in size, by adding new cocoons to the running thread as required, and this is an exceedingly difficult operation, requiring very great care; only the best reelers occasionally succeed in making a perfectly even thread. Up to the present time it has been extremely difficult to test the regularity of silk, and this has been one of the greatest and most universally felt wants in the trade. So difficult is it, that silk has been, and is yet, bought and sold very much according to the reputation of the establishment at which it has been reeled, it being impossible to judge accurately of the regularity of any silk until made up into goods, when the defects become apparent, and mar the beauty of the fabric. Irregularities also cause breakages, and consequent expense, waste, and knots, during the manufacture of the silk, and are therefore especially to be avoided. An approximate method of testing, called "titrage," has been employed. This consists in winding off and weighing numerous samples of thread of an equal known length. The differences in weight give the irregularities of the average weight of each sample, but the method is extremely defective and laborious, its worst defect being that a sample of a given length may be regular and of the same size throughout, or, on the other hand, extremely irregular and uneven, without affecting the result, as the errors balance one another. The "titrage," therefore, is of very little value as a test of the regularity, and is rather employed as a means of judging of the average size. The operation of the

"Serigraph" is as follows:—The silks to be tested are either wound upon a bobbin or placed, if in hanks, upon a swift, in such manner that it can unwind freely, and pass continuously through the machine. The end of the skein, or of the silk on the bobbin, is then taken to the machine, passed several times round a small drum, covered with india-rubber, thence to an agate hook, which is mounted at the end of a pendulum, hanging vertically, at a distance of half-a-yard from the drum, thence round a second drum, which is mounted upon the same shaft, and turns with the first, and is like it, covered with india-rubber. After making several turns round this second drum, the end of the silk is attached to a reel, which receives it as it leaves the machine. An essential point in the machine is that the second drum is larger than the first. The thread being mounted as described, the drums are put in motion, and the test begins, and is made as follows:—At any given yard in its length, the silk is first drawn in by the first drum, and is wound round it, and delivered by it towards the pendulum, with a speed exactly equal to that of the surface, and of the drum itself. As the silk leaves the first drum and passes the pendulum hook, it is drawn in by the second drum with a speed 3 per cent. greater than that with which it is delivered by the first drum. This happens because the second drum is larger than the first, and therefore being on the same shaft, its surface has a greater velocity. The effect of this arrangement is to stretch each yard of silk 3 per cent. at the time it is passing the hook on the pendulum. Silk being an exceeedingly strong and elastic thread, the force required to make this elongation is quite sufficient to pull aside a pendulum carrying a pencil point, and sufficiently heavy to cause the pencil to make a distinct and clear mark. All the pendulums on these machines are supplied with pencils, and there is an endless band or roll of paper, which is fitted to run under the point of the pencil, and to advance while the machine is running, with a speed equal to one five-thousandth that of the silk which is passing the first drum. The thread and paper being arranged as described, the machine is put in motion. There is at once produced a tension upon the thread between the two drums which draws the pendulum to one side, until by its weight it opposes a force equal to that required to stretch the silk. When this point has been reached, the pendulum remains stationary as long as there is no change in the silk passing the hook, and as the paper advances, a straight line is traced upon it by the pencil. But with the passage of the least irregularity in the silk, as either more or less force is required to balance the stretch, the pendulum and its pencil assume a new position, and the line upon the paper is changed. As it is impossible to produce a perfectly regular silk, the pendulum and the pencil are in constant motion, and the line produced upon the paper is more or less controlled and curved. The practical result is that all the defects and irregularities of the silk are shown upon the paper, exaggerated about one hundred and twenty thousand times, and drawn by the machine itself to a regular scale, so as to form a continuous diagram. The indications of the quality, and the workmanship of the thread, are perfectly distinguishable, and an exactitude is attained in this test which exceedes that in any other. About a foot in length of the diagram represents a mile of thread, and the speed of the machine is such that this mile of thread can be run through it, and all its irregularities exposed in ten minutes. Besides being fitted for showing irregularities, yard by yard, the "Serigraph" also measures the silk, and is arranged to stop automatically when a desired length has been wound off. It has also an automatic arrangement which causes it to stop instantly if the thread breaks.

Notes on Books.

PRESERVATION FROM FIRE. By J. H. Heathman. London: Simpkins, Marshall & Co. 1882.

Mr. Heathman's book is intended to give householders and proprietors of warehouses, &c., information as to the precautions which should be taken to reduce risk from fire, the measures required to minimise loss from fire which has broken out, the proper steps for dealing with a fire in its earlier stages, and similar points. The book concludes with a suggested code of instructions for use on premises where there are numbers of workpeople.

THE WATCH AND CLOCKMAKERS' HAND-BOOK. By F. J. Britten. Fourth edition. London: 1881.

The original edition of this hand-book was issued some time ago; but, according to an introductory note, considerable additions have been made to the present issue It contains a variety of miscellaneous information, useful to the class for whom it is intended. Besides the more special information dealing with the actual mechanism of clocks and watches, some pages are devoted to arithmetical and geometrical information standards of time, differences between Greenwich and local time in various parts of the world, various tables, date marks employed in Hall-marking, &c.

General Notes.

NEW INCANDESCENT LAMP.—The *Athenæum* states that Mr. Werdermann has just patented a new incandescent lamp. The peculiarity of this lamp consists in the fact that the vacuum, indispensable in all other such lamps, is dispensed with. Mr. Werdermann employs silicium in place of carbon, and, according to the paper quoted, he has succeeded in procuring from it better results than if carbon were employed.

USES OF GLYCERINE.—Price's Patent Candle Company are anxious to obtain all the information they can as to the various very numerous uses of glycerine. The firm would be greatly obliged if any members of the Society who are acquainted with any of the uses of glycerine in the manufactures would communicate them in a note addressed to Mr. J. C. Calderwood, Belmont Works, Battersea.

LIGHTNING CONDUCTORS.—A set of rules for the erection of lightning conductors, based upon the recently published report of the Lightning Rod Conference, has been issued by the Explosives Department of the Home Office to the occupiers of all factories and magazines for explosives, and to those local and police authorities upon whom devolves the inspection of stores of explosives.

CITY AND GUILDS TECHNICAL INSTITUTE.—The Council of the Institute have announced that, owing to unavoidable delay in the completion of the workshops and the laboratory fittings, the opening of the Technical College, Finsbury, is postponed until January, 1883. Arrangements, however, have been made for carrying on the work of the college, during the winter term, in all its departments, in the temporary class-rooms of the Institute, Cowper-street, Finsbury.

THE ST. GOTHARD TUNNEL.—It appears that the traffic through the St. Gothard Tunnel has increased, since the inauguration of through international services, to such an extent that the Company have already obtained sanction for laying the second pair of rails in the tunnel. The Great Eastern Railway Company has increased its steamer traffic, and built additional station accommodation at Harwich. Meanwhile, the Antwerp authorities have provided more convenient quay accommodation, just above the city; but the new station of the Belgian States Railway, which is to be transferred to this spot, does not progress so fast as the works on the English side.

WASTE PRODUCT.—It is stated that at the Gartsherrie works of the Messrs. Baird, the gases that were wasted in the production of iron have now been made to do double duty. Not only have they been utilised as is common by being put to the heating of boilers and other kindred work, but before this is done they are now made to yield the tar, ammonia, &c., which they contain. It is said that this is effected without disturbing the smelting process, and without materially lessening the value of the gases for the purpose to which they have been put. It is evident that if this in general practice becomes as satisfactory as it is believed to have done experimentally, there will be a considerable gain to the iron trade. A similar process is now in successful use in the coke trade of South Durham, where the Messrs. Pease have introduced it from France; and where it is being extended to others of their coking collieries, with the same result—the commercial production of ammonia, &c., from the waste gases given out in the process of the manufacture of coke. And there is, as is well known, a third great industry in which there is an attempt to use what has long been a waste product; this is the German process for the recovery of sulphur, which seems to have been successfully introduced into this country.—*Engineering.*

AMERICAN PATENTS.—Great activity appears to be maintained in the American Patent Office, the number of patents issued up to the last day of August being 263,669. The following is the proportion of one week's issue of patents to inventors belonging to the various States:—New York, 74; Massachusetts, 42; Pennsylvania, 32: Illinois, 31; Ohio, 21; Indiana, 19; California and Connecticut, each 14; New Jersey, 12; Wisconsin, 11; Missouri, 9; Iowa and Kansas, each 8; Rhode Island and Maryland, each 7; Georgia and Michigan, each 6; Minnesota, Texas, and Virginia, each 5; Arkansas, Nebraska, New Hampshire, and North Carolina, each 3; Maine, Tennessee, and Vermont, each 2; and one each for Colorado, Delaware, Columbia District, Idaho, Nevada, Oregon, and West Virginia. More interesting than the actual figures is the relation of the physical character of the State and its people to the general groove in which the inventions run. New York, for instance, deals principally with mechanical applications and scientific discoveries, and especially in matters relating to railways, machinery, and hardware. In New England States the tendency is almost entirely in favour of labour-saving machinery and particularly as applied to small and apparently trifling things. Again, in the West and South, the bulk of inventions relate to agricultural machinery, while in the Pacific States and among the Rocky Mountains they are almost entirely confined to mining matters. In fact, the Patent Office of a great country like America becomes, as it were, a kind of geographical index to the wants and requirements of the people. In the week ending August 29, there were also twenty-one patents taken out by inventors belonging to foreign countries, of whom 12 were English, four from Canada, two from Germany, and one each from Denmark, France, and Switzerland. With all this profusion of inventive talent, it is sad to state that from well-founded calculations it has been proved that not more than one inventor in a hundred gets any returns for his trouble.—*Times.*

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

LABELS FOR PLANTS.

The Council of the Society of Arts offer a Prize of Five Guineas, which has been placed at their disposal far the purpose by Mr. G. F. Wilson, F.R.S., for a Wooden Plant Label, saturated with paraffin, or some other preparation which would preserve the label, and would be likely to keep the writing upon it legible, either with or without the aid of paint, for five years. The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

The labels will be tested by the Committee with the view of ascertaining, as far as can be done in a limited time, whether they would be likely to stand prolonged use. It is believed that satisfactory tests can be made in a month or two. Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society not later than the 1st June, 1883. The Council reserve to themselves the right of withholding the prize offered if, in the opinion of the judges, none of the specimens sent in are deserving.

PUBLIC HEALTH.[*]

It has been long known, in many of those diseases which we term infectious or contagious, that by separating the individual attacked from the community, we may check the spread of the disease, and this practice has long prevailed.

The recent valuable and interesting report by your able medical officer of health, Dr. Armstrong, illustrates how the spread of scarlet fever and typhus have been checked, in this town of Newcastle, by the isolation of cases by removing them to hospital: and how careful and systematic vaccination has secured immunity from the scourge of small-pox.

In some towns, the local authorities have obtained power to compel the registration of all cases of infectious diseases within their jurisdiction. But it is very difficult effectively to isolate a patient in his own home; hence the further question arises as to what arrangements should be adopted for ensuring to the public the best means of isolation.

Special hospitals have been the panacea proposed; but a suspicion has recently arisen that if all cases of infectious diseases are concentrated in a special hospital in an inhabited district, this concentration of disease may have tended to intensify the disease, and disseminate it in the neighbourhood.

Under the circumstances of the existing law, we must mainly trust to voluntary effort to prevent the spread of infectious disease; and I may here quote the experience of a nurse of twenty years' experience, in dealing with the most infectious and dangerous of these diseases, viz., scarlet fever. Her chief practice was the common one in respect to all cases of the various epidemics—to isolate the patient in a single room, the upper room if possible, and let no one else enter it; to so arrange as to keep the door and part of the window open, in order to let a current of air pass through the room over the patient; to observe all the details of regulations as to the cleanliness of the patient and the articles of clothing and furniture, and the removal of excreta, &c.; and as to her own personal protection, never to drink out of the same vessel that had been used by the patient, and especially to wash from head to foot twice a day with tepid water, and to change her clothes each day; moreover, she was careful never to serve in conditions of exhaustion with an empty stomach. With these precautions, she had never had a single case of the spread of the disease to a member of the family or anyone else during the twenty years; nor had she once contracted the disease herself.

Notwithstanding the numerous experiments, and the great efforts which have been made in recent times to endeavour to trace out the origin of disease, the sanitarian has not yet been able to lift up the veil which conceals the causes connected with the occurrence. These diseases come in recurring periods, sometimes at longer, sometimes at shorter intervals. Animals, as well as the human race, are similarly affected by these diseases of periodical recurrence; but why they prevail more in one year than in another, we are entirely ignorant. They appear to be subject to certain aerial or climatic conditions. Cholera affords an illustration of this.

There is a part of India, low-lying, water-logged, near the mouth of the Ganges, where cholera may be said to be endemic. In certain years, but why we know not, it spreads out of this district, and moves westward over the country; the people are sedentary, and seldom leave home, but the cholera travels on. At last it arrives on the borders of the desert, where there are no people, and no intercourse, no alvine secretions, and no sewers, yet the statistician sitting in Calcutta can tell almost the day on which the epidemic influence will have crossed the desert. But it exercises discrimination in its attacks. It will visit one town or village, and leave many others in the vicinity untouched. Similarly, it will attack one house and leave another. But it has been generally found that the attacked house or village held out a special invitation from its insanitary condition. The same houses or the same localities will be revisited in recurring epidemics, because the conditions remain the same; remove those conditions, and at the next recurrence the locality will escape.

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[*] Abstracted from the inaugural address by Capt. Douglas Galton, C.B., Hon. D.C.L,, F.R.S., &c., &c.; President of the Congress of the Sanitary Institute at Newcastle-upon-Tyne.

At Malta it was found that the same localities and houses which yielded the majority of plague deaths there in 1813, yielded the majority of the deaths in the cholera epidemics of 1839 and 1867; and that in the intervals the same localities yielded the majority of cases of small-pox, fever, and of an anthrax, a very special eruptive epidemic attended by carbuncles.

Hence, whilst we are unable either to account for the cause or to prevent the periodic recurrence of epidemic diseases, the sanitarian has learned that it is possible to mitigate the severity of the visit; and that whether these diseases arise from the occult causes to which I have alluded, or from other causes, pure air and pure water afford almost absolute safeguards against most forms of zymotic disease.

Water has for many years been the subject of careful examination and analysis; indeed, in the water supply for our large towns water examination may be said to be an ordinary branch of the service. So long as the country was sparsely inhabited, the question of the pollution of rivers was comparatively unimportant, because when sewage is discharged into running water, provided the primary dilution of the sewage with pure water be sufficient, the removal of the organic impurity will be effected after the run of a certain number of miles, the precise distance of travel being dependent on several conditions. Perhaps the most beautiful instance of the self-cleansing power of a river is afforded by the Seine at Paris, where the river, which is black and foul when it leaves the town, becomes comparatively clear and full of water plants and fish at some ten or twelve miles lower down. But the numerous centres of population in England, and shortness of the rivers, leave them no time to exercise these self-cleansing processes; and some of the most important sanitary legislation in recent years has been devoted to the preservation of our rivers from pollution. It is, however, shown by Dr. Angus Smith's reports, under the Pollution of Rivers Acts, that either by the application of sewage to land, or by some of the methods of defecation which I will not further enter upon here, water from sewage may be so purified as to be placed in a flowing river without mischief. And although there are many theories as to how far water which has once been contaminated by sewage may again, after a time, become fit to drink, I am disposed to think that there has never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly, on analysis, have condemned the water as an impure source; and it appears probable that, whatever may be the actual cause of diseases, *i.e.*, whether germs or chemical poisons, the *materies morbi* which finds its way into the river at the sewage outfall is destroyed, together with the organic impurity, after a certain length of flow. Considering the density of population over the whole country, it is to be regretted that so much time has been lost in bringing these Acts into operation; and it is to be hoped that there will be no further delay in strictly enforcing the provisions of the Rivers Pollution Act.

With respect to air, the question is somewhat different. It is nearly fifty years ago since that able sanitarian, Mr. Chadwick, impressed on the community the evils which were caused by the impure condition of the air in our towns, owing to the retention of refuse round the houses. In considering this question it is necessary to discriminate. The gases which are the result of putrefaction are offensive to the smell, and some of them, as, for instance, sulphuretted hydrogen, are dangerous, in that they may kill people outright if they are present in undue proportions in the air; or, if air containing smaller proportions of these gases be breathed for a long time, the general tone of the individual inhaling them may be lowered, but they do not produce specific diseases. When, however, the putrefaction has gone on for some time, it may result in leading to the development of other conditions which may become the cause of disease, or death.

In connection with this question, M. Gustave Le Bon published recently in the *Comptes Rendus* some experiments relating to the properties and the influence of antiseptics on the volatile products of putrefaction. He prepared a liquid made up of water and hashed meat. He placed a frog in an enclosure with some of the liquid. When putrefaction first set in, a very fetid odour was produced, and the liquid swarmed with bacteria, and he states that in this condition it is a very virulent poison if injected under the skin of an animal; but the frog, merely breathing the effluvia, took no harm. After two months, the strong fetid odour had much diminished; the liquid had ceased to have virulent properties when injected under the skin, but the animal breathing its volatile products was rapidly killed by them. There is thus no parallelism between the virulent power of a substance in putrefaction, and the toxical power of the volatile compounds given off by it, indeed these powers seem to be in an inverse ratio. Moreover, the older the putrefaction, the weaker is the disinfectant power of any antiseptic over it.

These experiments are consistent with the observation that an offensive smell is often less injurious than the slighter fetid odour from an old drain; and that putrefying matter left for a long time in ashpits or manure heaps may be a source of danger; and it is also consistent with the observation that emanations from decomposing matter in the soil, such as refuse in old cesspools, or the stagnant deposit of sewage in badly constructed drains, may produce very dangerous results, although the odour is not strongly offensive, and they justify the established axiom that all refuse matter should be removed as rapidly as possible from the vicinity of dwellings.

There is no doubt that, in the sewering of towns, want of experience in the construction of the works has, in some cases, led to deposits in the sewers, and in consequence of the failure to remove these dangerous gases, evil consequences have ensued; but it may be accepted as certain, that in every case where the sewerage has been devised on sound principles, and where the works have been carried on under intelligent supervision, a largely reduced death-rate has invariably followed.

But whilst the retention of refuse is probably the most fertile cause of mischief, there are other questions connected with the purity of air to which it is useful to direct our attention. Dr. Angus Smith has given us very valuable information on this subject, in his "Contributions to the Beginnings of a Chemical Climatology." He shows that the air in the middle of the Atlantic Ocean, on the sea-shore, and on uncontaminated open spaces, commands the greatest amount of oxygen; that at the top of hills the air contains more oxygen than at the bottom; and that places where putrefaction may be supposed to exist are subject to a diminution of oxygen. For instance, a diminution of oxygen and an increase of carbonic acid is decidedly apparent in crowded rooms, theatres, cowhouses, and stables. It is well known that oxygen over putrid substances is absorbed, whilst carbonic acid and other gases take its place; and hence all places near or in our houses which contain impurities diminish the oxygen of the air.

Let me explain to you what this diminution of oxygen means. The average quantity of oxygen in pure air amounts to 21 parts out of 100. In impure places, such for instance, as in a sleeping room, where the windows had been shut all night, or in a lecture theatre after a lecture, or in a close stable, the oxygen has been found to be reduced to as little as 20 parts in 100. That is to say, a man breathing pure air obtains, and he requires, 2,164 grains of oxygen per hour. In bad air he would, if breathing at the same rate, get little over 2,000 grains of oxygen an hour, that is a loss of about 8 per cent.; and this diminished quantity of oxygen is replaced with other, and in almost all cases, pernicious matters. The oxygen is the hard-working, active substance that keeps up the fire, cooks the food, and purifies the blood; and, of course, as the proportion of oxygen in the air breathed diminishes, the lungs must exert themselves more to obtain the necessary quantity of oxygen for carrying on the functions of life. If the air is loaded with impurities, the lungs get clogged, and their power of absorbing the oxygen that is present in the air is diminished. An individual breathing this impure air must therefore do less work; or, if he does the same amount of work, it is at a greater expense to his system. In towns, the impurity of air arises chiefly from dust of refuse, mostly horse manure, as well as from smoke, and other products of combustion. The influence of smoky town air on health is, to some extent, illustrated by the fact that the death-rate of 23 manufacturing towns, selected chiefly for their smoky character, averaged 21·9 per 1,000 in 1880; whilst the rural districts in the counties of Wilts, Dorset, and Devon, excluding large towns, averaged 17·7 per 1,000; and the deaths from the principal zymotic diseases in the towns were more than double those in the rural districts.

Mr. Aitken, of Edinburgh, has made some very interesting experiments, showing that visible fog is due to particles of foreign matter floating in the air. He showed that the vapour of water injected into air, from which particles had been strained out, was not visible; whereas, as soon as foreign matter, such as dust, or smoke, or fumes, and especially fumes of sulphur, were introduced, the aqueous vapour condensed on the particles, and became visible as fog. He showed that some kinds of dust have such an affinity for water, that they determine the condensation of vapour in unsaturated air, whilst other kinds of dust only form nuclei when the air is supersaturated; and that dry fogs are produced by those dust particles whose affinity for water vapour enables them to condense vapour in unsaturated air. Amongst this class of dust may be instanced chloride of sodium or salt, which largely pervades the atmosphere, and is probably derived from sea spray; also ammonia, which is present in town air, and may be largely due to the manure. In towns where the streets are paved with stone, asphalte, or wood, and even where the surface is of macadam composed of granite, the chief part of the mud and dust consists of horse manure, which continually gives off the fumes of ammonia; and this substance, when mixed with fumes of sulphur, has a greater power of condensing aqueous vapour than the products of combustion of pure coal, and gives rise to a very fine-textured dry fog.

The conclusions which may be drawn from these experiments are:—1st, That when water vapour condenses in the atmosphere, it always does so on some solid nucleus; 2nd, That the dust particles in the air form the nuclei on which it condenses; 3rd, If there was no dust in the air there would be no fogs, no clouds, no mists, and probably no rain; but when the air got into the condition in which rain falls—that is, burdened with supersaturated vapour—it would convert everything on the surface of the earth into a condenser, on which it would deposit itself. Every blade of grass, and every branch of tree would drip with moisture deposited by the passing air; our dresses would become wet and dripping, and umbrellas useless; but our miseries would not end here. The inside of our houses would become wet; the walls and every object in the room would run with moisture. Hence we have in this fine dust a most beautiful illustration of how the little things in this world work great and useful effects in virtue of their numbers. This dust pervades the air everywhere. The haze in the air on a summer's day is caused by dust, which is probably largely composed of the pollen of flowers. This dust appears to occupy the lower strata of air, for in the valleys on the south or Italian side of the Alps a blue haze mellows the view; but this is passed through after a little hill-climbing, and the atmosphere becomes clearer. The theory is not inconsistent with the formation of the loftiest clouds, because dust does not only pervade the lower region of the atmosphere.

Mr. Langley was making observations last autumn on the spectrum of the sun on Mount Whitney, which is within some 300 miles north of the Mexican frontier, and about 200 miles from the Pacific Ocean. When at a height of 13,000 feet above the sea, he observed dust in the atmosphere between him and the sun. He computed that this dust was at a height of 1,000 to 1,500 above the elevation at which he was placed; that is to say, at a total height of from 14,000 to 15,000 feet above the sea. It has been suggested that this dust might have been carried by the prevailing winds from the plains composed of loess in China.

There is, however, another source whence dust in the air at higher altitudes may be derived; for recent investigations show that appreciable quantities of meteoric dust are being constantly brought into our atmosphere from interplanetary space. In our towns the dust is more plentiful, but there also it diminishes with elevation. The clumsy and barbarous method which we adopt for burning coal in this country add to the dust the fumes which necessarily result from combustion, as well as a quantity of soot and tarry matter from the imperfect combustion of coal. Mr. Chandler Roberts, who made experiments on the question of the amount of soot from different forms of grates for the Smoke Abatement Society, found the quantity of soot to vary from about one per cent. in most furnaces, to as much, in some instances, as three per cent. of the fuel consumed in domestic fire places; that is to say, the imperfect combustion causes from one to three cwt. of soot for every five tons of coal consumed. This soot assists in forming the black canopy which it is fashion in England to consider the proper attribute of a large town.

Dr. Frankland and Dr. Russell have shown that the tarry matter which arises from the combustion of coal coats over the water resulting from the aqueous vapour thus condensed upon the particles of dust, and considerably delays their re-evaporation; consequently, whilst the atmosphere of large towns is more favourable to the development of fog, the fogs prevailing over large towns are more persistent in their character than in the open country. Moreover, the fumes from combustion contain substances, and especially sulphur, which appear to be more favourable to the formation of fogs than any other form of dust; and, therefore, even if whilst continuing to burn coal in our towns we get rid of smoke, we should still have products of combustion, which would favour the occurrence of fogs; but they would be fogs of lighter colour and less persistency than our ordinary London smoke fog.

The conclusions at which Mr. Aitken has arrived from his experiments are well illustrated by a fact of every day experience. A heavy fall of rain washes the particles of dust out of the air, and after the rain the fog is often removed, and the air of a town is much clearer. But in addition to the chemical and inorganic constituents of air, which have been generally taken as a measure of its purity, recent researches have divulged to us the character of some of its organic impurities.

Dr. Tyndall has shown us, by passing a ray of light through a space otherwise dark, that all air is more or less filled with dust; that this dust is destroyed by incineration, and that it is, therefore, chiefly organic; and his experiments, made with infusions previously freed from all possibility of containing germs in the infusion, or, as he terms it, sterilised, demonstrated that this dust contains germs which are always ready to spring into life when a congenial medium for their development is at hand. He shows that if the air of a room be left absolutely undisturbed for some time, this dust is more rapidly deposited than in moving air. Thus in a sheltered and quiescent position in a room, flasks filled with various infusions developed organisms more rapidly than those placed in the more open parts of the room.

Dr. Tyndall has also shown, by similar experiments, that these sterilised infusions did not develop organisms when exposed to the clear mountain air on the Bel Alp in Switzerland, whilst the air of a hay-loft near the glacier developed organisms in 90 per cent. of the flasks containing sterilised infusions.

M. Marie Davy, of the Montsouris Observatory of Paris, tells us that the air near to the Hotel Dieu in the centre of Paris and near an opening to a sewer, is more prolific in causing the development of bacteria and similar organisms, in prepared sterilised infusions, than air in the more open space near the Montsouris Observatory; and that the latter is more prolific than air on the plateau of Gravelle near Paris. M. Davy also tells us that the air in rainy weather is less prolific in producing bacteria; that it becomes more prolific during the drying up of the rain; but becomes less prolific again in drought and in sunshine. Similarly, the numbers of bacteria are very small in winter; they increase during the spring; attain their maximum in autumn; and then decrease with the rain and cold weather on the approach of winter. The cold of a Parisian winter is inimical to them, and so is dry hot weather, and especially sunshine. It is not alleged that those various organisms are all productive of disease or injurious to the higher forms of life. Some are, no doubt, productive of what we term putrefaction, others may be productive of disease, but some may possibly afford nourishment. It is, however, noteworthy that those observations which show the presence of organisms in certain localities, and in certain conditions of the atmosphere, seem to present coincidences with other observations on the prevalence of certain disease, which at least make it desirable that the inquiries should be further pursued. For instance, in the Punjab the mortality from fever deaths in each of three consecutive years, 1872-73-74, when food was cheap, and when there was no extraordinary occurrence to affect the ordinary relations between fever and rainfall, only began to rise after the rainfall had attained its maximum and had begun to decrease, and the deaths from fever attained their maximum soon after the rainy season came to an end, during the drying up of the ground, after which they decreased. In Bombay the registered fever deaths, on a mean of fourteen years, show a minimum of fever deaths during the hot, bright, and dry season. It is also noteworthy, more especially in hot climates, that those rooms of a house into which sunshine can penetrate are healthy, whereas rooms where no sunshine can penetrate are not healthy.

In our present knowledge, it would be premature to draw any conclusions from these various researches; but they open out an interesting field of inquiry, which it is not presumptious to think may possibly have some bearing on the prevalence of disease. But whatever may be the influence which such organisms or germs exert on the production of zymotic diseases, the sanitarian has attained to the absolute certainty that the number of persons who are attacked by this class of diseases can be increased or diminished in proportion to the defects or the excellence of the hygienic conditions under which they are living.

I have already mentioned to you the effects of sewerage on the mortality of towns. On the general effect of sanitary conditions upon health, the experience of the Indian army is very striking. Periodic fevers occur everywhere in India, and there arise extra vicissitudes of temperature and endemic causes of dangerous disease. Yet there, even under these circumstances, sanitary work, by removing preventible causes of disease, has reduced the death-rate of the European Army in India from 60 per 1,000, to 16 per 1,000, and is gradually diminishing the death-rate of the civil population.

Perhaps one of the most conclusive examples of the effect of sanitary observances is that furnished by fairs and religious festivals in India. These assemblies bring together many thousands of persons, sometimes even as many as 100,000 persons, together with numerous horses and cattle. They form a huge encampment, lasting for three days, sometimes for weeks. A very few years ago, there was no care taken to prevent the fouling of wells and water-courses, or to regulate the disposal of the refuse which was scattered all over the surface of the ground where this multitude encamped. These fairs and festivals were, therefore, almost invariably foci for the spread of cholera and other diseases. Now this is all changed. Stringent regulations preserve the wells and water-courses from pollution, and compel the people to deposit all refuse in prepared places. All the rest of the ground in the vicinity of the encampment is kept scrupulously clean. Since this has been done, many festivals and fairs have been held in districts where cholera has been prevalent, but yet, owing to these stringent regulations, no cases of cholera have occurred amongst the persons attending the fairs and festivals. We may find, perhaps, more striking results from the influence of sanitary work in India, or in a tropical climate, than elsewhere; but still we are surrounded by numerous examples of the effect of sanitary work at home.

In the Army in Great Britain, the deaths from tubercular disease used to be 10 per 1000—in fact, equal in amount to the total deaths which now occur in the Army in peace time. The improvements in the hygienic conditions under which soldiers live, which were introduced into the Army in consequence of the recommendation of the Royal Commission on the Sanitary State of the Army and the Barrack and Hospital Commission, have reduced the death-rate from tubercular disease to about 3 per 1000. This is one of the diseases which it is now alleged can be, or is, propagated by germs; and it is to this point that I desire especially to call attention, viz., that whatever be the manner in which these zymotic diseases are propagated, the death-rate and consequent sickness may be diminished or increased according to the sanitary conditions in which a population lives.

Within limits, it is not the density of population which regulates the health. But if a dense population is spread over the surface, or close to the surface of the ground, by which means all movement of air is prevented, and if there are numerous corners in which refuse is accumulated, it will be difficult to prevent disease. Dr. Angus Smith's experiments show that whilst there is less oxygen and more carbonic acid in the eastern and in the more crowded parts of London, yet that in open spaces the amount of oxygen rises, and the carbonic acid diminishes very considerably; and that we are exposed to distinct currents of good air in the worst, and equally to currents of bad air in the best atmosphere, in towns like Manchester. Dr. Tyndall showed that where there is quiescence in the air, the tendency of his sterilised infusions to produce organisms was increased. The conclusion from all these experiments is to show the importance of laying out the general plan of dwellings in a town, so that currents of air shall be able to flow on all sides with as little impediment as possible, by which means the air will be continually liable to renewal by purer air.

The dwellings which have been constructed in the place of the very defective dwellings condemned by the medical officers of health, in various parts of

London, specially illustrate the importance of this question of the circulation of air. These dwellings replace those in which the normal mortality was as much as thirty-three, fourty-four, and fifty per 1,000. But these improved dwellings provide ample space all round the blocks of building, so that air can flow round and through them in every direction, and so that there are no narrow courts and hidden corners for the accumulation of refuse. The mortality in the new dwellings is as low as thirteen per 1,000 in some, and does not rise above twenty per 1,000 in any of them, and upon an average of years it may be taken at from fourteen to sixteen per 1,000.

It is to this point that I specially desire to draw your attention, viz., that these facts prove the possibility of bringing down the death-rate of the class of population which inhabits this sort of accommodation to rates varying from fifteen to sixteen per 1,000. I say of the class of population, because habits and mode of life have an important influence on health and on longevity.

We have done much for the health of young people by the Factory Acts, in regulating their labour; and we have made stringent rules to compel their attendance at school; but in these latter regulations it is to be feared that the health of the children has been too little considered. Mr. Chadwick and Dr. Richardson have long pressed upon the consideration of the public the defects of the elementary school system, first, as to the insanitary conditions of the rooms in which most of the school work is performed, and secondly, as to the advantages which have been found to result from making physical training a portion of ordinary school work. Dr. Richardson shows that the long hours spent in school do not produce results commensurate with their length. That is to say, he shows that in those schools where half the time is allotted to physical training, the children learn quite as much as in schools where the whole time is devoted to study; that the children are brighter, and that they are eventually turned out of the school better qualified to take up the avocations of daily life.

On the other hand, the condition of the children is an important factor in the ventilation of a schoolroom. With children who are not washed all over daily, the skin and the clothes assist in producing a foul atmosphere; and the rooms crowded with children in that condition require special means of ventilation. Unless this is provided, the atmosphere is injurious. But, as a rule, the children are not thoroughly washed every day, nor are exceptional means of ventilation provided. From some recent statistics, it appears that the death-rate of elementary school teachers amounts to as much as twenty per 1,000, which is more than double that of soldiers on home service, and about four times that of the police or of sailors, in which forces, apart from deaths from accident or violence incurred in their profession, it amounts to about five per 1,000. It is even from five, six, to seven times greater than that of those criminals who are imprisoned who have no specific specific disease, amongst whom, when they enter a well-conditioned prison, the death-rate does not exceed three per 1,000. The sickness will be protioned to the death-rates; and there can be no question but that the high death-rate is largely due to the unhealthy atmosphere in which their work is performed.

Dr. Carpenter says, in his work on "Human Physiology," that the "purity of the atmosphere habitually respired is essential to the maintenance of that power of resisting disease which, even more than the ordinary state of health, is a measure of the real vigour of the system. For, owing to the extraordinary capability which the human body possesses of accommodating itself to circumstances, it not unfrequently happens that individuals continue for years to breath a most unwholesome atmosphere without apparently suffering from it; and thus, when they at last succumb to some epidemic disease, their death is attributed solely to the latter, the previous preparation of their bodies for the reception and development of the zymotic poison being altogether overlooked."

It is not so many years ago that the death-rate of the Army at home nearly equalled that now prevailing among the elementary school teachers. The large army death-rate was shown to arise from defective ventilation and want of other sanitary arrangements. These were remedied, and the Army death-rate was reduced to from eight to eleven per 1,000; and there can be no doubt that if the same care were bestowed upon the purity of air in and around our schoolrooms, as is bestowed upon our barrack-rooms and prison-cells, the health of school teachers and of the children would be materially benefited.

The following extract from a paper by Mr. Chadwick sums up this experience:—"In one orphan institution the progress made by the application of sanitary factors was thus denoted. The death-rate amongst the children was twelve in 1,000. The impurity of the air was removed by better drainage, and the death-rate reduced to eight in 1,000. A further advance was made by regular head-to-foot ablutions of the children with tepid water, and a complete skin cleanliness maintained, when the death-rate was reduced to four in a 1000. In the district half-time schools, near London, where the sanitation is the best advanced, they receive children of the lowest condition and type, and may be said to be children's hospitals; but of those who come in without any developed disease, the death-rates from disease of spontaneous origin do not exceed three in 1,000, or one-third of those of children in the Board or common schools. I deduce from experience, that skin cleanliness and clothes cleanliness is a factor of prevention of the common death-rates amongst dirty children, in crowds or in schools, by one-third."

Mr. Chadwick further dwells on the economy of cleanliness. He states that it has been ascertained that pigs that are washed put on one-fourth more flesh from the same quantity of food than do pigs that are unwashed. The food that would be required for four children that are unwashed would serve for five children that are washed. A general whose army was hemmed in and put upon short rations encouraged his men to bathe daily; he said that by that means he kept his men in as good condition and force as another division of the army that was on full rations, but unwashed. I am informed by colliery proprietors that horses in a colliery which are well groomed do more work and look better than badly groomed horses with an equal amount of food. And there is a German proverb which may be translated: "Well washed is half the feeding."

My object in presenting to you these facts is to show you that you must not be satisfied with an average death-rate in your towns of 21·8 per 1,000, but that you should investigate the death-rate in each part of your town, and in each class of your population at several ages, and ascertain where it is in excess, and what are the causes of the excess, and then do your utmost to remove those causes. For the death-rate is an indication of the degree of wasted force in the country. Let us consider for a moment the losses to the country which are evidenced by a high death-rate. Take a professional man who has accumulated a large amount of knowledge, and, what is better, of experience; or take an artisan who is a skilful craftsman. They die in the prime of life, when they are most fitted to use these qualities; the knowledge, experience, and skill, which have required many years, and much labour and expense to accumulate, all go with them, before the crop of usefulness, in the cultivation of which so much has been expended, has ripened and been gathered. But there is also to be considered the loss by sickness. The death-rate affords, to some extent, an index of the disease-rate in the community. It is, however, very difficult to ascertain, with any degree of accuracy, the disease rate of a community, as compared with the death-rate. If we take the Army as a criterion, it would seem that there are more than 100 men admitted to hospital to one death, whilst the number constantly sick averages from four to six times the number of deaths. No doubt, in the Army, many an ailment has to be treated in hospital which in ordinary life would allow the sufferer still to pursue his avocations.

The sickness of the population is not registered, and it is very difficult to obtain any data respecting it. It has been generally stated that there are on an average twenty cases of sickness to one of death, of which four out of five are of children. I find, however, from a return of an unsanitary district in St. George's-in-the-East, that with a death-rate of thirty-one per 1,000, the sickness rate was 270 per 1,000, or nine cases of sickness to one death. But in the worst parts of the same district the sickness-rate amounted to 620 per 1,000, which gives twenty cases of sickness to one death.

Mr. Neison, who has recently examined the records of the Ancient Order of Foresters, shows that at thirty-five years of age there are, on an average, twenty-two cases of sickness to one death, and that is in a body of men which, it must be borne in mind, are selected men as far as health is concerned. From the same record, we find that, at twenty years of age, the loss of time from sickness amounts to 1·5 per per cent. of the whole time; and at forty years of age it amounts to 2·6 per cent. The value of a single premium paid at twenty years old (calculated on the 3 per cent. table), to £1 a week during sickness, for the whole life, is £40. I sought, but failed to obtain, definite statistics on this subject from some of those who are working amongst the poor, both in the East and West-end of London. An East-end clergyman remarked that "the poor go on living wonderfully in wretched places, but that they have so much ill-health. They are perpetually on the trudge to the hospitals with their bad chests and bad legs, and get patched up again and again, and live on."

Our London hospitals and dispensaries cost, according to Mr. Burdett's statistics, nearly £600,000 annually to administer. The average number of out-patients treated at the various institutions in a year is about 1,000,000—that is to say, more than one out of every four inhabitants of the metropolis becomes an out-patient in the course of the year. This expenditure is incurred mainly for the purpose of patching up the wretched poor, who have been injured by bad drainage, want of ventilation, darkness, &c. Though drink may be one of the immediate causes of many hospital cases, yet the tendency to drink is created and fostered by the wretched dwellings of the very poor. But besides the time lost by the sickness itself, there is the large amount of time wasted by the poor in going to and waiting at hospitals, which would be spent by healthy poor in labour. There is, moreover, the great amount of lassitude and idleness in the low-class poor, which Dr. Richardson traces to want of ventilation, in their own and former generations.

I think we may safely assume that if we can, by preventive arrangements, bring down the death-rate of the wage class to the standard afforded in good sanitation, you would reduce the sickness rate in a similar proportion at least. By means of this item alone the wage earning power of the industrious classes would be enlarged by some millions of pounds, and their comfort correspondingly increased. You would effect, in addition to the savings under this head, certain other distinct economies. For instance, it is certain that the need for much of the accommodation in our prisons, reformatories, and workhouses arises from evils incident to unhealthy circumstances and crowded dwellings.

We shall probably be led to appreciate more fully the advantages of good sanitation, if we can arrive at putting a money value upon some of the results of sanitary improvements. In the first place, the community derives a direct advantage from adopting such a system for the removal of refuse as will enable it to be applied directly to improving the cultivation of land. For whilst, on the one hand, the rapid removal of refuse from the neighbourhood of dwellings by the efficient sewering of towns results in improved health, the application of sewage to land by the irrigation of growing crops affords both a means of fertilising the land, and of cleansing the fluid, so as to place it in a fit condition to pass into the streams. My friend, Mr. Chadwick, asserts that where the sewage is undiluted with rain-water, and where it is utilised at once, and carefully applied under favourable conditions, an acre of land ought to absorb the sewage of hundred persons, and that the crops on this area should feed five cows; or, if put in another way, that the produce of ordinary cultivation being represented by one, and market-garden produce by three and a-half, the produce of sewage cultivation should be represented by five. I have obtained some recent facts on the direct application of sewage to land which, although they do not show such high results, deserve attention.

Mr. Brundell, who has the management of the Doncaster Sewage Farm, states that during nine years he has never applied any other manure than sewage. That this year the crops are the heaviest that have been produced, and the land remains just as capable of receiving the sewage as it ever was, and does not "tire." Mr. Collett, of the Bedford Farm, says that their produce is generally much above the average of the neighbourhood, and that the crops are as good or better than they were seven or eight years ago; and the land under sewage treatment has improved in quality.

Mr. Champion informs me that at Reading, with sewage irrigation, they cut the Italian rye grass six and seven times in the season, as compared with two crops without sewage; that mangolds grown with sewage produce from fifteen to twenty tons per acre more than when grown in the usual way; that their oat crop this year yielded from fourteen to fifteen quarters per acre, the straw being from seven to eight feet high, and remarkably stout and stiff.

Colonel Jones, of Wrexham, tells me that, "having farmed many hundred acres during the last three years for the landowners who had farms thrown on their hands, I have had some opportunity of comparing actual results of farming, with and without the resource to be derived from a town sewer, and I have no hesitation in saying that produce may easily be doubled per acre by the proper use of sewage as regards any crop, and that four or five times the weight of grass is a certainty in any season; and it is simply a question of management and market, whether or not a sewage farm can be made to pay."

There are occasionally, no doubt, difficulties to be overcome in the application of sewage to land, and some eminent advocates of the conversion of sewage into manure have said that if the sea is at hand it is better to throw sewage into the sea than to utilise it. But that is not the language used in speaking of the manure of an ordinary farm; yet the one is, in its way, and under its own conditions of use, as valuable for improving crops as the other. Farmers say that one of the best ways of obtaining manure for the land is not to buy artificial manure, but to buy oil cake or other suitable food, and to feed sheep and cattle upon that; and land is largely manured by means of oil cake and Indian corn imported from abroad as food for domestic animals. A recent investigation showed that one-third of the food which is consumed by the people of this country comes from abroad; and, therefore, if we applied the sewage of our population to our land, we should enrich the land by the millions of quarters of foreign corn and the thousands of tons of foreign meat which are imported and consumed in the country; and, so far from the land of England deteriorating under such conditions, it ought to become richer, year by year, by these enormous importations of food. Therefore, whatever may be the trouble and expense in individual cases of applying the sewage to the land, the application, so far as the interests of the community are concerned, must add to the stored-up wealth of the country. In the next place, the diminished death and sickness rates, and the greater length of life entailed by good sanitation, afford direct pecuniary advantages.

Let us apply this reasoning to the population of the Improved Artisans' Dwellings in London. These now accommodate about 11,000 families. In many of the districts which are now covered by these improved dwellings, the death-rate in the wretched homes which have been removed varied, as I have told you, from thirty to forty and even fifty per 1,000. Mr. Gatliff shows that there are nearly five in a family on an average in model-lodging houses. There has thus been a saving of life, to the extent of at least twenty per 1,000, by the erection of these dwellings, on the 50,000 persons inhabiting them, or about 1,000 deaths annually. And if we take the estimate of sickness which I arrived at above, there would be a reduction in the number of cases of sickness which occur in the population of these dwellings of at least from 15,000 to 20,000. The cost of the improved dwellings appears to have averaged a little over £170 each, or about £1,900,000 for the 11,000 families.

By the light of these various data we may obtain some idea of the actual pecuniary advantage to the community which results from the improved health of the occupants of such dwellings. The cost of funerals has been stated to average £5 a-piece. Under this head, therefore, the saving may be taken to average £5,000 a-year; the diminished loss of the sickness of the 11,000 heads of families alone may be assumed to average another £5,000 a-year; and in addition to this, there would be the saving in time and money, in seeking medical attendance, of the wives and children who make up the remaining population of the dwellings, as well as the increased power of earning wages afforded to the mothers of families from the diminished sickness of the children. Hence the money benefit to the community thus made up, which is caused by the diminished death-rate and sickness-rate, would form an appreciable item in the per-centage of interest paid on the £1,900,000 capital expended in the construction of the dwellings.

But there is another way in which we may estimate the economy to the community resulting from the increased health which has been obtained in these dwellings. The analysis of the mortuary rates for Westminster showed that the mean age at death of the males of the wage classes in Westminster, who had survived the period of youth, and died after 20, was 47·6 years. The rate of mortality in the improved dwellings is from fourteen to sixteen per 1,000. The rate of mortality in the rural parishes of Northumberland in the years 1877-81, was 15·3 per 1,000; and in Dover in 1880, it was 16·7 per 1,000. It will not be unfair therefore to take the mean age at death of the males who died over 20 in the rural parishes of Northumberland and in Dover as a standard which may be reasonably expected for the duration of life of the males who die over twenty years of age in the improved dwellings. This was, for the rural parishes of Northumberland, 60·9 years, and for Dover it was 57·8 years, That is to say, from 10·2 to 12·3 years, or a mean of 11 years additional duration of life may be expected for the heads of families occupying the improved dwellings, beyond that enjoyed by the wage classes who do not live in such favourable surroundings.

Therefore we may assume as a profit to the community the increased earning power of the occupants of these dwellings, due to this increased expectation of life. It would appear, from Mr. Neison's tables, that 6 per cent. would be a full average deduction for sick time between forty-seven and fifty-eight years of age; and we may therefore safely take the increased earning power as that due to an additional 10·4 years of life. If, in order to form a rough estimate of the money value of this, we assume that each of the heads of the 11,000 families receives as a present on his admission to the dwellings a grant of ten years more life, and calculate its money value on the earnings of only £1 a week, we find that upon a four per cent. table the present value of ten years of increased wage-earning power, at £1 per week, would be, for 11,000 heads of families, £4,640,000, or nearly two and a half times the cost of the property. By considering the question in this way, we arrive at an understanding of some of the direct pecuniary advantages which accrue to the nation from those sanitary improvements which lead to a decreased death-rate and sickness-rate; and we see that, however large may be the cost of the removal of bad dwellings, and the substitution in their place of healthy well-planned dwellings, the actual money gain to the community far exceeds the expenditure in money. But it is not as a money saving alone that the question must be considered. Its social and political bearings are even more important. The nation is made up of individual items. The goodness and the happiness of the nation depend upon the individual. Well-regulated family life does more to make up individual happiness than any other form of life. But family life is impossible in the wretched homes which have been permitted to exist in most of our large towns, and many of our rural parishes. These wretched homes drive the population into the streets, and into the gin palaces, and into the public houses. They engender sickness, which entails poverty, and they foster crime. The improved dwellings, on the other hand, ensure improved health; and by thus affording a security for the more continuous earning of wages, create the possibility of a comfortable home. I was much struck, when in the United States of America, with the fact that the artisan and wage classes, in many manufacturing towns, lived in very comfortable houses, in which each family had their parlour with appropriate furniture, pictures, and often their piano. They had come to look upon these things as a necessity; and this is an evidence of the general civilisation which pervades American society. By civilisation, I mean the education and the general well-being of all classes. In this country, our most advanced sanitarians have long endeavoured to impress these doctrines on the public, and I am happy to think that at last they are beginning to bear some fruit; for, in order to develop morality, contentment, and happiness among a people, it is essential that they should be provided with healthy and comfortable homes.

AN ELECTRIC LAUNCH.

Dr. Silvanus Thompson gives in the *Times*, of the 29th September, the following account of an experimental trip in a launch propelled by means of electricity:—

Having been one of a privileged party of four, on board the first launch ever propelled upon the waters of the River Thames by the motive power of electricity, I think some details of this latest departure in the applications of electric science may be of interest.

At half-past 3 this afternoon I found myself on board the little vessel *Electricity*, lying at her mooring off the wharf of the works of the Electrical Power Storage Company at Millwall. Save for the absence of steam and steam machinery, the little craft would have been appropriately called a steam-launch. She is 26 ft. in length and about 5 ft. in the beam, drawing about 2 ft. of water, and fitted with a 22-inch propeller screw. On board were stowed away under the flooring and seats, fore and aft, forty-five mysterious boxes, each a cube of about ten inches in dimensions. These boxes were nothing else than electric accumulators of the latest type, as devised by Messrs. Sellon and Volckmar, being a modification of the well-known Planté accumulator. Fully charged with electricity by wires leading from the dynamos or generators in the works, they were calculated to supply power for six hours at the rate of four-horse power. These storage cells were placed in electrical connexion with two Siemens's dynamos of the size known as D 3, furnished with proper reversing-gear and regulators, to serve as engines to drive the screw propeller. Either or both of these motors could be "switched" into circuit at will.

In charge of the electric engines was Mr. Gustave Phillipart, jun., who has been associated with Mr. Volckmar in the fitting up of the electric launch. Mr. Volckmar, himself an engineer, completed, with the writer, the quartette who made the trial trip. After a few minutes' run down the river, and a trial of the powers of the boat to go forward, slacken, or go astern at will, her head was turned Citywards, and we sped—I cannot say steamed—silently along the southern shore, running about eight knots an hour, against the tide. At thirty-seven minutes past 4 London-bridge was reached, where the head of the launch was put about, while a long line of onlookers from the parapets surveyed the strange craft that, without steam or visible power, without even a visible steersman, made its way against wind and tide. Slipping down the ebb, the wharf at Millwall was gained at one minute past 5, thus in 24 minutes terminating the trial trip of the *Electricity*.

For the benefit of electricians, I may add that the total electromotive force of the accumulators was 96 volts, and that during the whole of the long run, the current through each machine was steadily maintained at 24 ampères. Calculations show that this corresponds to an expenditure of electric energy at the rate of $3\frac{1}{11}$-horse power.

It is now 43 years since the Russian, Jacobi, first propelled a boat upon the waters of the Neva by aid of a large but primitive electro-magnet engine, worked by galvanic batteries of the old type, wherein zinc plates were dissolved in acid. Two years ago a little model boat was shown in Paris by M. Trouvé, actuated by accumulators of the Faure-Planté type. The present is, however, not only the first electric boat that has been constructed in this country, but the very first in which the electric propulsion of a boat has been undertaken on a commercial scale. Looking at this first practical success, who shall say to what proportions this latest application may not attain in the next decade?

General Notes.

ARTIFICIAL GRAPHITE.—The Chevalier Jervis, Conservator of the Royal Italian Industrial Museum at Turin, has sent the Secretary a note upon a new artificial graphite, invented by an Italian named Conte. The graphite is said to be chemically pure, and quite homogeneous. It is crystalline, black, and with a metallic lustre. It is very elastic, and therefore considered suitable for incandescent lamps, for which purpose it has been tried. Signor Jervis reports that it answers very satisfactorily. Lamps fitted with this material have been sent to the Electrical Exhibition, which is now open at Munich.

RUSSIAN TRADE WITH CHINA.—The establishment of a line of Russian steamers between the ports on the Yangtse and in North China, and Nikolaevsk, Vladivostock, and other harbours in Eastern Siberia, of which mention was made in the papers recently, is part of an old project for increasing the Russian trade with China. For many years past the tea from Han-kow and Foochow, intended for the markets of Moscow and Nijni Novgorod, was conveyed by water to within a few miles of Peking, whence it was transported by camels across Mongolia to Kiachta and Kalgan. It was then conveyed through Siberia to European Russia. The cost of the Mongolian carriage was half-a-million sterling on an average, and constant complaints of the thieving and misconduct of camel drivers were made. It is now intended to ship the tea in Russian steamers at the Chinese ports for Vladivostock and the mouth of the Amoor. By the river boats it will be conveyed to within a short distance of Irkutsk, which will in future, it is hoped, become the mart of the Russian tea trade. It remains to be seen whether the transhipments on this route will cause deterioration in the tea. At present a great difference is made between the caravan tea and that which is brought by steamer from China to Odessa and the Baltic ports. The latter is generally called Canton tea, and fetches a much lower price. The importance of the caravan trade may be estimated from the fact that about thirty-five millions of pounds of tea are annually conveyed to Kiachta.—*Pall Mall Gazette.*

SELF-CONTAINED ELECTRIC LOCOMOTIVE.—In a recent communication to the Paris Société d'Encouragement, M. E. Reynier described the electric locomotive, devised by M. C. Dupuy, for running along the bleaching grounds of M. Duchenne-Fournet, at Breuil-en-Auge, in the department of Calvados. The vehicle carries a Siemens's electro-motor, which not only propels it at a speed, if required, of over seven miles an hour, but also a series of rollers for unrolling along the grass, and again rolling up the pieces of cloth to be bleached, these actions being also performed by the motor. The electricity is supplied by 60 Faure accumulators, charged by the dynamo-electric machine that supplies the electric light, and these, as so much room is occupied by the cloth rollers, have to be carried by a tender. The engine will draw after it five trucks of seven tons weight, also carrying cloth rolls. A large or smaller mumber of accumulators may be put into the circuit, as may be required by the exigencies of the road or work; and the engine will run either backwards or frontwards. It was stated at the meeting that the locomotive is a thorough success, and can be constructed, commercially, for 6,000 fr. (£240), including the accumulators, being thus cheaper than steam, hot water, or compressed air.

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CANTOR LECTURES.

BOOK ILLUSTRATION, OLD AND NEW.

By J. Comyns Carr.

Lecture I.—Delivered May 8th, 1882.

It is a remarkable fact, in regard to the history of art, that the most important principles which should guide the artist in his work are commonly most clearly expressed in the earliest productions. What is called progress is very often as much a departure from such principles as the development of them, and in all periods of artistic revival there is as much to unlearn as to acquire. If we seek, for example, for the highest principles of pictorial design, we find that they are as firmly established in the work of Giotto, as in the more mature achievement of Michael Angelo; and in regard to that particular branch of art which I am about to discuss, the earliest examples offer to us the best and finest models of system and style.

With such a text as book illustration, it would be easy to wander into a general consideration of the progress of design. In its widest scope, book illustration has afforded a reflex of every variety of artistic invention; and it is, indeed, difficult so to limit our view of the subject as to make it possible for discussion within the time at our disposal. But my intention to-night is to consider book illustration less in reference to the intrinsic merit of the art that has been produced in its service, than in regard to the particular conditions which should govern its expression; and here I may say at once that I do not intend to discuss in detail all the varied processes that have been, from time to time, employed in the adornment of printed volumes.

In the stricter view of what really belongs to the art, it may be said that the history of book illustration is, in fact, a history of wood engraving. It is, no doubt, true that in later times other modes of artistic expression have been employed, and many sumptuous volumes have issued from the press, adorned with admirable specimens of lithography, both in monochrome and colour, of photography, and of engravings on steel and copper. Such adornments, however, although they may give added interest and beauty to a printed volume, can scarcely be said to come legitimately within the scope of our subject.

The very finest steel engravings, however adroitly and tastefully they may be introduced into a printed book, have no natural right to the place which they occupy. They are like the bright petals of a flower which has been accidentally imprisoned in its pages, and the more delicate and refined the execution displayed by the engraver, the less will the result be found to harmonise with its surroundings. In order clearly to understand why this should be so, it is necessary to advert for a moment to the different mechanical conditions which govern the production of engravings on wood and steel. The principles of beauty in art are nearly always determined by simple physical laws, and the reason why there is no natural companionship between printed text and impressions from steel or copper-plates, is that the processes employed in their production have absolutely nothing in common. I may, perhaps, be allowed to insist upon this distinction, which is no doubt already familiar to most of you, for it possesses paramount importance in connection with the subject we have to discuss. A wood block, however elaborately it may be cut, is in principle only a complex piece of type. It is printed in the same way, and by the same means, and its effects should always possess something of the same simplicity of character. You are aware that the impression of a printed page is taken from the raised surface of the type. The ink rests upon this raised surface, and is transferred, under moderate pressure, to the surface of the paper. Precisely the same description applies to the production and printing of a wood engraving. The wood block, before the artist has begun to carve his design upon it, is represented upon paper by an even surface of pure black. In order to transform this black space into a picture, the wood engraver proceeds to cut away all that he does not require for his purpose. His method is, in fact, the method of the sculptor, who gradually liberates his subject from the surrounding mass of marble in which it is imprisoned, and the block, when completed, is like a piece of sculpture in relief, with this difference and qualification, that the forms have no contour or modelling, but present throughout a uniform surface, upon which the ink rests, and from which it is ultimately transferred to the paper. Now, the methods of the artist who works upon copper or steel are exactly the converse of this. If we could suppose that a copper-plate could be placed upon a printing press, the impression produced from it, instead of corresponding with the artist's design, would give us everything that the artist had intended not to represent. The methods of the engraver on metal exactly correspond to the ordinary methods of an original drawing; and that is why a painter, who would be puzzled if he had to express himself on wood, can, with comparative ease, produce an etching on copper. The printer's impression here tells line for line as it has been traced upon the metal. The ink, instead of resting upon the raised surfaces, rests in the furrows produced by the acid or the graver, and is transferred to the paper by means of strong pressure, in a press specially designed for the purpose. But the process here employed has nothing in common with typography. The plate has to be carefully prepared for each separate impression, and the mechanical means employed for the rapid reproduction of printed text and wood engraving, are wholly inapplicable to the more delicate work of the engraver on metal.

It is remarkable that, in the earliest examples of the art, the whole page, text and picture alike, were all carved upon a block by the hand of the artist. But, before block-books were known, the taste for illustrated books had been established and cultivated by the exquisite designs to be found in illuminated manuscripts. No illustration that has since been offered to the world can equal in beauty and taste the lovely pages of illumination, where the thought and skill of the artist seem almost as much concerned with the text as with the ornament or design on which it is framed, and where the two elements are so skilfully combined as to leave the sense of the whole being a picture of which the written portions form an integral part. The authors of the illuminated manuscript fixed for ever the true principles of book illustration. The exquisite sense of fitness between the page and its picture, which belongs to the best of these early works of art, has never been surpassed, even by the most sumptuous and splendid examples of modern typography; and so deeply were these principles of design impressed by the artist of these early times, that they were successfully transferred to the mechanical process of printing. From the illuminated manuscript to the block-book the transition is easy and natural. Here, again, the whole of the page is designed as a single picture, the balance of text and illustration is carefully adjusted, the forms of the old characters are carved with the same artistic feeling and finish that animates the illustrative design. It is remarkable that an English artist of modern times should have almost exactly reproduced this early system of book illustration. William Blake, whose instinct in all matters of decorative fitness was always true, produced several of his works, which are now so prized by collectors, by means which strictly resemble the early block-book. He understood and appreciated the beauty that comes of a perfect correspondence between the text and its adornment, and he was wont to engrave his poems upon zinc plates, biting away with acid all that was not required for the purposes of the text and the bordering design. The principle which Blake here apprehended, and which we find again in the earliest examples of book illustration, is that which is most often neglected by the modern artist. It is too common to find that the engraving inserted in the text has been executed without regard to the position in which it is to appear. The artist is apt to forget that, in the effect produced upon the eye, the text which surrounds his picture will, of necessity, have an important influence; and he is disposed to treat his illustration as an isolated picture that has no particular connection with its surroundings.

The various modes of modern wood engraving I shall reserve for description on a future occasion; but in considering what are the principles that should determine book illustration, it is impossible not to be struck with the constant neglect of those finer qualities of taste which are so clearly established in the very earliest specimens of the art. By this I do not mean, of course, that the block-books are the earliest extant examples of wood-engraving. The block-books belong to the middle of the 15th century, but wood-engraving had already been known and produced for some considerable period; it was used, as we are told, in attesting documents so early as the 13th century; but its first important development is found in connection with the production of playing cards by the German cardmakers, in the beginning of the 15th century.

The Germans were the first to practice card-making as a trade, and they largely exported their wares, produced at Augsburg, into the cities of North Italy; nor was it until the year 1441 that the card makers of Venice obtained an order from the magistrates, directing that no foreign manufacture of printed cards should be any longer imported. These printed cards were usually coloured with a stencil placed over the block. It was only natural that this mode of reproducing impressions of a design should speedily be adopted by the church, for the purpose of circulating among the people figures of the saints. Possibly the card makers were themselves employed in the service of the church; and it is at any rate certain that the earliest sacred subject engraved on wood, the celebrated block representing the St. Christopher, in the possession of the Earl Spencer, and which bears the date 1418, was found in the convent within fifty miles of the city of Augsburg. This print, like the early cards, is coloured by means of a stencil plate; the design is of considerable size, measuring 11¼ inches in height, and 8 inches in breadth, and shows a quality of art superior to that which enters into the illustration of the earliest printed books.

There are several other early wood blocks which rank with the St. Christopher in point of time and style. One of these is the design of the Annunciation, preserved in the same volume which contains St. Christopher; another represents the Martyrdom of St. Sebastian; and a third, St. Bernardin, is preserved in the National Library at Paris. There is one characteristic which belongs to wood engravings of this period, and which is dependent upon the process by which they are afterwards coloured. In the original block, it is not uncommon to find that certain parts are left untouched, or partly indicated, with the view of being afterwards filled up by means of the stencil plate.

It would not serve our purpose to-night to enter into a detailed examination of these early wood-cuts, although they possess the highest interest in connection with the development of an art which was destined to be permanently associated with the production of printed books. Our special concern just now is to follow the progress of pictorial illustration in its relation to literature, and here, as I have already stated, the next step in advance is marked by the production of what are known as block-books, which date from about the middle of the 15th century. The block-book forms an important connecting link between the illuminated manuscript and the later achievements of the printing-press. It has this in common with the illuminated manuscript, that it is the harmonious and coherent result of a single artistic process, and the finest block-books possess for this reason a certain completeness of effect, which could never be secured even by the most elaborate and beautiful specimens of mechanical typography. The great charm of the illuminated manuscript consists in the fact, that the spirit of the artist seems to enter as much into the transcription of the text as into the invention of ornament or design which accompanies it. The whole bears the stamp of human handiwork and of human individuality; a quality that, from this point of view of art, is of higher value than the utmost perfection of mechanical skill. Something of the same peculiar fascination belongs to the block-books; although many of them are of comparatively little value, in point of artistic refinement and skill. The block-book, as it name implies, is a book, printed text and illustration together, from a carved block. Before the invention of moveable type, the demand for the general ciculation of popular religious works, doubtless, led to the employment of the wood engraver's art, which had already found exercise in multiplying the figures of the saints. The exact date and place to which the origin of these block-books is to be ascribed is somewhat uncertain, but it seems probable that the earliest specimens were produced in Holland, some years before the middle of the 15th century. I have said that these books have an intimate connection with the illuminated manuscripts which they superseded, and this is clearly shown by the fact that, in many instances, original manuscripts are still in existence, from which the engravers of the block-books obviously derived their inspiration. The works most freely circulated by this means are the "Apocalypse," the "Biblia Pauperum," and the "Ars Moriendi;" and in several instances the manuscript prototype is still in existence. But although these early engravers were clearly dependent upon the illustrators of the illuminated manuscripts for the material of their work, it would be misleading to assume that the results they achieved are in any sense comparable to the models from which they are taken. Mr. Quaritch, to whom I am indebted for much valuable suggestion in connection with this subject, has pointed out that the labour of engraving these books must, in many instances, have been entrusted to workmen with little art or skill in the management of their material; and certainly there are several considerations which go far to support this theory. In the first place, the engravings in the block-books are, in many instances, not up to the level of the art of the time. Mr. Chatto has pointed out that the block of the "St. Christopher," of which mention has already been made, and which is, undoubtedly, to be ascribed to an earlier date, is artistically of much finer quality than most of the illustrations to the works issued from the printing press; and there are instances of blocks inserted in manuscripts produced before the year 1440 which prove that the cuts in the block-books do not, as a rule, afford a fair index of the resources of the art at the time. A superb manuscript of the "Apocalypse," secured by Mr. Quaritch at the Didot sale, containing designs of the highest artistic beauty and excellence, goes further to prove that the block-books, as a rule, were rough and rude imitations of the originals, executed by journeymen rather than by trained artists. But there are brilliant exceptions to this general rule, and the British Museum is fortunate in possessing one of the very finest of these block-books, which has recently been reproduced by the Holbein Society. This is the "Ars Moriendi," acquired in 1872, from the Weigel collection at Leipsic, for the sum of £1,072 10s., the highest price ever paid by the trustees for any printed book. But this precious possession, whatever it cost, must be reckoned of inestimable value, as an early and admirable specimen of book illustration. Unlike most of the other block-books of the period, it is a genuine and admirable work of art, and it is only necessary to compare the cuts with those contained in other versions of the work, in order to realise the superior claims possessed by the author of the original edition. Mr. Bullen, in a most interesting essay, prefixed to the Holbein Society publication, fixes a later date for the "Ars Moriendi," than for most of the other block-books with which we are familiar. "The manufacture of block-books," he writes, "commenced in Holland, and afterwards practised in Belgium, appears to have travelled about in the middle of the 15th century into Germany, and fixed itself at Cologne, where this edition was in all probability executed;" and it is certainly true, as he proceeds to point out, that the illustrations betray the influence of the lower Rhenish school.

It may be taken as a capital illustration of the skill and resource possessed by the earliest wood-engravers, and it seems to settle once for all the principles which determine all manner of decoration for printed books. Of course, the general qualities of art displayed in these designs are those which might only be expected in the period in which it was produced; but what we have now to remark is the fine tact and taste with which the execution is adapted to the purposes of book illustration. The lines, though few, are admirably chosen to give effect to the artist's purpose, and throughout his work he would seem to have been constantly mindful of the relation which his picture should bear to the cut letters of the text. It may, of course, be said that the style which I am here holding up for admiration was imposed upon the artist by the imperfect resources at his command, and that he would have come nearer to the modern view of the wood-engraver's craft, had he possessed the necessary knowledge and experience of what can be accomplished. But this, even if true, cannot be held to affect the question we are discussing. The world of art is not an arena for the exercise of feats of manual dexterity, and the greatest artist is not he who encounters and conquers the greatest difficulties, but who most willingly submits himself to the obvious conditions which the particular style of design imposes. To my mind, the most elaborate and intricate specimen of wood-engraving which our modern times have produced, compare but poorly with the simple and abstract qualities displayed by the engraver of the "Ars Moriendi;" and I believe that many of the failures which have overtaken modern art, are due as much to the temptation which is afforded by increased facilities in technical practice, as to any other cause.

There are many other of the block-books which, if time allowed, would be worth description and study; but their use to us on this occasion lies in the fact that they mark a particular epoch in the development of book illustration. The last of them, which is also to be seen in the British Museum, was produced in Venice, in the year 1510, and is the work of Giovanni Andrea Vavassore. It is more elaborate in character than the "Ars Moriendi," and in the picture design there is a more ambitious attempt to secure fuller effects of light and shade. It anticipates, in a measure, the next revolution in the art of publication, consequent upon the invention of moveable type. This invention, at first, seems to have exercised a depressing influence upon the practice of wood-engraving.

The cutting from the letters for the text had no doubt formed an important part of his business, and the introduction of typography of necessity deprived him of a valuable means of subsistence, but the decline was but temporary. Under the protecting influence of the printing press, the wood-block rapidly acquired increased prominence, for it became the means of circulating engraved designs throughout every part of civilised Europe.

To follow the subsequent fortunes of engraving in wood would require a separate consideration of the art of Italy and the North, but it may be said, generally, that as Germany had been the first to encourage the engraver's art, so also it produced, in a more mature period of its development, the finest and most interesting specimens. It has been sometimes doubted whether Albert Durer was himself an engraver on wood, but it is certain his great genius must have powerfully influenced the practice of this branch of art. No man ever possessed a finer instinct for the varying conditions under which his designs were to be reproduced; his mode of technical execution for engraving on copper has been a model to all the world since his time, and in like manner he exhibited an equal judgment in the management of designs destined for reproduction on wood.

Many of the wood blocks executed at this time far exceeded the limits of book illustration. Such, for example, are the series of designs by Durer, for the triumph of Maxmilian, who was himself a constant patron of this branch of art. At the same time wood engraving received a new development, by the invention of the system known as *chiaro scuro*, of which the earliest example is found in the reprint of the "Repose in Egypt," by Lucas Cranach. This mode of engraving, which consists in the use of two or more blocks, so printed as to imitate the effect of a washed drawing, may be taken as indicating a new departure in the wood engraver's art. It marked the first attempt to make wood engravings a means of reproducing pictorial effect, and although in itself sufficiently simple, it may be reckoned as the source and origin of the many modern efforts in the same direction. In fact, in its modern application, wood engraving has almost ceased to possess distinct claims of its own. It is employed as a means of reproducing drawings in wash or colour, or to imitate the free and careless handling of a pen and ink sketch. The result has been that the wood-block has lost its distinctive character of fitness for its place in a printed volume. It is true that the earliest wood-blocks were *facsimile* reproductions of an artist's design, but then the artist laboured with a definite view of the process by which his work was to be translated, and of the place it was destined to fill. He preserved in his design something of the abstract character that belongs to printed type; the lines by which he expressed his thought were few, simple, and severe; he sought for no suggestion of colour, nor did he strive for great depth or variety of light and shade. It is a characteristic of all early engravers, a characteristic specially marked in the early wood-blocks, that they are founded rather upon the principles of sculpture than of painting. The light and shade are evenly balanced over the whole composition, subtleties of local colour are neglected in favour of a clear, sharp definition of broad effect, and the result appeals more by beauty and balance of form, and by truth and simplicity of character, than by laboured difficulty of executive skill. It may, perhaps, be said, that wood-engraving of this earlier and nobler kind reached its highest perfection within ten years of the time of Durer's death.

The "Dance of Death," which may be taken, all things considered, as the very finest specimen of the art, in existence, was published at Lyons, in the year 1538, and Holbein's designs to the volume may be taken to sum up, in a form of supreme excellence, those principles in the engraver's art that had been gradually developing themselves in the previous hundred years.

"So admirably," says Chatto, in his treatise on wood engraving, "are those cuts executed, with so much feeling and with such perfect knowledge of the capabilities of the art, that I do not think any wood engraver of the present time is capable of surpassing them. The manner in which they are engraved is comparatively simple, there is no labour and unnecessary cross-hatching where the same effect might be obtained by simpler means; no display of fine work merely to show the artist's talent in cutting delicate lines; every line is expressive, and the end is always obtained by the simplest means. He wasted not his time in mere mechanical execution, which, in the present day, is often mistaken for excellence. He endeavours to give each character its appropriate expression, and in this he appears to have succeeded better, considering the smaller size of the cuts, than any wood engraver either of times past or present." This estimate of Holbein's work is certainly not extravagant, and yet, if it be taken to be just, we must admit that the modern wood engraver has departed very far from the ideal which Holbein set before himself. Certainly, in the mass of work now produced, there is very little trace left of the principles upon which Holbein laboured. Instead of proceeding by the simplest means, our modern artist seems rather by preference to take the most difficult and complex way of expressing himself. A wood-engraving, it is not unjust to say, has become scarcely distinguishable from the steel-engraving, save by its inferiority. It strives after equal complexity of colour and tone, although the resources at the command of the artist are by no means fit for the attempt. When it appears in a printed volume, the modern wood-cut looks for the most part like an unsightly stain upon the page. It bears no relation to the text which surrounds it, and which it is assumed to illustrate. The heavy mass of deep tone seems to make a hole in the page, and however we may admire the quality of the work, judged apart, and on its own merits, we are bound to confess that it has been produced without consideration of the conditions under which it is to appear.

The original cause of this decline in the art has been already indicated. Envy of the effects proper to another mode of expression is the death of every art. Literature cannot reproduce the beauties proper to painting or design. Sculpture, whatever claims of its own it may possess, is powerless to give us the glow and colour of a Titian; and in like manner the wood-engraver, so far as he sought to place himself in competition with the engraver on copper, found that he was parting with the beauties peculiar to his own craft, without securing those that belong to another. During the latter part of the 17th century, the art may be said to have reached its lowest point, and the only book illustration of the 18th century that deserves much consideration, consists of delicate copper-plate engravings, produced by the French artists of the time.

These steel plates, it must be confessed, are often most skilfully introduced into the text, so as almost to produce the impression that they belong to the same process of printing, but I do not propose, whatever their merits, to discuss this class of illustrated books this evening

Book illustration, as an art, as I have already said, is founded upon wood engraving, and it is to wood engraving we must look if we are to have any real revival of the kind of beauty which the early-printed books possess.

If we look back then upon the condition of wood engraving during the period of its prosperity, we shall find certain clearly marked characteristics which specially fit it for association with printed books. We find, in the first place, that the artist, partly perhaps from limited resources, but much more from innate and trained sense of the requirement of his task, constantly preserved such a simplicity in his workmanship, that the result found happy companionship with the printed page. With the example of the illuminated manuscript still fresh in memory, he treated the page of a printed book as an entire composition, into which the picture was not to overbalance or oppress the remainder.

Miscellaneous.

THE MANUFACTURE AND PREPARATION OF JAPANESE LACQUER.

Of late years, large quantities of Japanese lacquer ware have been brought to this country, in the course of trade, and sold often at remarkably cheap prices. The markets, indeed, have been quite glutted with Japanese manufactures; nevertheless, the works of real art, in Japan lacquer, always realise a high price. It has been said that the process of lacquering, as known to the old Japanese workers, is, if not quite lost, becoming rapidly so in the present day, and that the modern system of lacquering is not calculated to stand the ravages of time, as was the work of a generation or two since. It is not to be supposed that the cheap lacquered articles of the present day, that are made simply to sell, will ever bear comparison, in workmanship, with the more costly and durable work, the make of which, as well as the polish are, notwithstanding their great age, as perfect as when they left the hands of the workman.

The date of the discovery of the art of lacquering, in Japan, is given by the Japanese as A.D. 724; some authorities, however, consider it to have been later, probably, indeed, about 889 or 900. It seems, however, not to have attained to any degree of perfection till the year 1290, "for the name of a distinguished painter in lacquer, who lived at that time, is still handed down as the founder of a particular school of art in lacquer-painting. From that time, it developed until it attained its present perfection."

A very elaborate report on the lacquer industry of Japan has recently been produced by Mr. J. J. Quin, H.M. Acting Consul at Hakodadi. This report has been drawn up "chiefly as a description of the articles of various kinds, illustrative of the lacquer industry of Japan, collected for the use of the Museum of Economic Botany at Kew." This collection is a most complete one, and is now exhibited in the No. 1 Museum, Royal-gardens, Kew. It comprises not only a fine series of finished lacquer articles, such as boxes, cabinets, bowls, trays, &c., both of ancient and modern workmanship, but also a very complete set of the instruments and appliances used in the manipulation of the lacquer ware, including specimens of the trunk of *Rhus vernicifera*, gashed to show the mode of extracting the juice or lacquer, together with the iron instruments used for this purpose; also a complete set of the lacquers themselves, and of the colouring matters used.

The following notes are abstracted from the report referred to, which is probably the most detailed account ever written of the lacquer manufactures of Japan. In his introduction the writer says:—"Great difficulty has been experienced in obtaining thoroughly reliable information, as not only are the artificers for the most part uneducated, but they are entirely ignorant of what takes place in any other department, except that to which they have been brought up. A well-known and most intelligent manufacturer, Takei Tōsuke, who has been over twenty years himself a worker in gold lacquer, and from whom great assistance has been derived in bringing together the present collection, was quite unaware of the mode of tapping and treating the trees, and had never seen a cut specimen of the wood until the pieces now forwarded were procured. He states that his head workman, a highly-skilled artisan, over fifty years of age, hardly knows the name of a single article that he uses."

The *Rhus vernicifera*, the well-known lacquer tree of Japan, is met with all over the main island, and also in smaller quantities in Kiushiu and Shikoku, but it is from Tôkiô northwards that it principally flourishes, growing freely on mountains as well as in the plains, thus indicating that a moderate climate suits the tree better than a warm one. Since early days, the cultivation of the tree has been encouraged by the Government in every province and district. The lacquer tree can be propagated by seed sown at the end of January or the beginning of February. The first year the seedlings reach a height of ten inches to one foot. The following spring the young trees are transplanted about six feet apart, and in ten years an average tree should be ten feet high, the diameter of its trunk two and a half to three inches, and its yield of lacquer sufficient to fill a 3-ounce bottle.

A more speedy method is, however, generally adopted. The roots of a vigorous young tree are taken, and pieces six inches long and the thickness of a finger are planted out in a slanting direction a few inches apart, one inch being left exposed above the ground. This takes place in the end of February and through March, according to the climate of the locality. These cuttings throw a strong shoot of from eighteen to twenty inches the first year, and are likewise planted out the following spring. Under equally favourable circumstances these trees would be in ten years 25 per cent. larger in girth, some two or three feet higher, and would yield nearly half as much more sap than the trees raised from seed.

It has not hitherto been the custom to bestow any special care on the trees after planting them out, but in cases where leaf or other manure has been applied they are much finer. Of late years hill sides and waste grounds have been used for lacquer plantations, as owing to the rise in price of cereals and farm produce generally, it does not pay the farmers to have their land cumbered with trees. Those that have been hitherto planted along the borders of fields are being rapidly used and uprooted, and, where practicable, mulberry trees are planted instead, with a view to rearing silkworms. Nevertheless, as a good workman is expected during the season to tap 1,000 trees ten years old, and as the province of Yechizen alone sends out 1,500 "tappers" yearly to the various lacquer districts, it will be seen that an immense production annually takes place, stimulated doubtless, by the demand for cheap lacquered articles abroad. It should also be mentioned that to remedy the possible exhaustion of the supply, and in view of the great rise which has taken place in the price of lacquer, several companies are being projected to plant waste lands with the tree. A ten year old tree, which some five years ago only cost one to two sen, now costs ten sen, which, allowing even for the depreciation in the value of paper currency, shows a rise of about 500 per cent.

The best transparent lacquer comes from the districts of Tsugaru, Nambu, Akita, and Aidzu. It is largely used by the workers of Kioto, Osaka, and the southern provinces, but though also used in Tôkiô, is not so much appreciated there as the lacquer produced from the neighbourhood of Chichibu, in the province of Mus-ashi, from Nikko, in Shimotsuke, and that produced in the provinces of Kodzuke and Sagami, which hardens more rapidly, and is the best for black lacquer. There are some districts the lacquer obtained from which is best for certain kinds of work, but is not so well adapted for others. The kind which is used for transparent lacquer is mixed in large tubs, to insure a uniform quality, and being allowed to stand for some time (say a week or ten days), the best portion, which is ordinarily 70 per cent. of the whole, is skimmed off. This is used for Nashiji and Shu lacquer, while the remainder is used for making inferior mixtures, such as Johana, &c. Almost all the various classes of lacquer are similarly dealt with to insure uniformity, as some qualities dry much quicker, and are better than others, and the slow-drying qualities would otherwise remain unsold.

The whole country produces on an average from 30,000 to 35,000 tubs per annum, each tub being of about four gallons capacity. Some 70 to 80 per cent. of this total amount is produced from Tôkiô northwards. Nearly one-half of the lacquer produced is sent to the Osaka market, where it is prepared as required, and resold all over the western and southern provinces, the remaining portion being used up locally and in Tôkiô.

The usual age at which a tree is tapped is ten years, but in some few cases a tree is tapped when only three or four years old. The best lacquer for transparent varnish is obtained from trees from one to two hundred years old, as their sap has more body, and is more glutinous. The tools used in obtaining the lacquer are as follows:—

Kawa-muki (bark parer), a curved knife, with which the workman smoothes all inequalities of the bark before tapping the tree.

Yeda-gama (branch sickle), an instrument with a gouge on one side and a knife on the other, fitted with a piece of bamboo to give the hand a good hold when tapping branches.

Kaki-gama (scraping sickle), a similar instrument, without the piece of bamboo, used for tapping trees generally.

Yeguri (a gouge), used in autumn to scrape the bark smooth before giving the final cut with the Kaki-gama.

Natsu-bera (summer spatula), used for scraping the sap out of the incision into the receptacle named *gō*.

Hōchô (knife), used for cutting the bark of branches in obtaining seshime or branch lacquer.

Seshime-bera (seshime spatula), used for collecting the sap which exudes from the incisions in the bark of the branches.

Gō, the bamboo or wooden pot in which the sap is put as it is collected.

Gō-guri (pot gouge), a long straight knife for scraping the lacquer out of the pot into the tub.

Te-bukuro (glove), worn by the tapper to protect his hand from contact with the sap.

The first tapping takes place about the beginning of June. The standard number of trees allotted to a tapper for the season is 1,000, presuming them to be about ten years old, or about 800 of the older trees, and so on less and less according to the size of the trees. Having cleared away the grass from the roots, the workman makes the round of his allotted trees, marking each with small notches about half-an-inch long. The first of these notches is made about six inches from the bottom of the tree on the right hand side; the next, one "hand stretch" higher up on the left hand side; the next one "hand stretch" higher on the right, and so on, alternately, as far as the workman can reach. These preliminary markings, which are to determine all the places for subsequent tapping, take fully four days, being at the rate of 250 trees a day. The tapper then goes round provided with the bark scraper, the ordinary scraping sickle, the summer spatula, and the pot to hold the lacquer, and first smoothing the bark where required, gives one cut above and one cut below the two lower marks, and one cut above the remainder of the other marks, the cut being in each case about an inch and a half long. After giving the cut, the instrument is reversed, and the knife is run along the incision to insure the bark being entirely cut through. This process is repeated every four days, each incision being made a little longer than the preceding one, up to the fifth tapping inclusive, after which the remaining incisions are made of the same length. At each round, when all the requisite incisions have been made on the tree, the workman gathers the sap which has been exuded with the spatula, beginning with the two lowest incisions, and so on to the uppermost cut. Twenty-five is considered the normal number of cuts, which, at the rate of one incision at each place every four days, occupy 100 working days, and allowing for some twenty days of rain, during which the sap cannot be drawn, the season is brought to a close about the end of September. If the workman has any large trees to tap, the whole of which he cannot reach, when his round is concluded, he returns with a ladder, and, mounting each tree, taps the remainder of the trunk and the leading limbs in the same manner as above described, previous to making a fresh round.

When the full number of incisions has been given, the workman gives an extra long cut underneath all the initial notches on each tree to obtain the sap which has collected there, and another above the uppermost cut of each set. These incisions are called *ura-me* (back marks). The workman also makes a number of cuts, each about a foot apart, in all the branches whose diameter exceeds one inch. This operation requires about sixteen days to get through the whole number of trees. The next operation is called tomé (the finish). This consists of a number of incisions completely encircling the tree wherever the workman perceives a likely place. The next process consists of cutting off all the branches; the larger ones are once more tapped after being cut off to extract any sap that may still remain in them, and the small branches, which have not yet been tapped, are tied in bundles and steeped in water for about ten days. When taken out and dried, the bark is cut with a knife, and the sap which exudes is collected with a branch spatula, and is called seshime lacquer. This word seems to be derived from *sehi*, the name of a machine, and *shimeru* (to press), from a practice which obtained in olden days of pressing the branches in such a machine to obtain the sap. It is also known as *yeda urushi*, or branch lacquer.

The sap obtained from the first five cuts above each notch is poor, containing, as it does, a large proportion of water; the middle fifteen cuts produce the best sap, a the sap obtained from the last five incisions is poor, and lacks consistency. Again, the sap obtained from the *ura-me* (back marks), the tomé (finishing) cuts, is very good, and dries quickly. The sap from the first twenty-five cuts is mixed and sold together; but the *ura-me* and *tomé* sap is almost always mixed and sold separately. The operations above described kills the tree in one season, but frequently the tree is made to last two years or more, by giving only half the number of incisions, and reserving the *ura-me* and *tomé* cuts for the final year. The sap obtained the second and following years is, however, of an inferior quality, and this method is only resorted to by private individuals, who tap their own trees during intervals of farming. Ordinarily, a wholesale dealer in lacquer buys so many thousand trees from the owner, and, as a matter of course, extracts the sap with as little delay as possible, making a contract for the purpose with professional tappers. A first-rate workman will receive over 100 yen (equal, at the present low rate of exchange, to nearly £13 sterling) for the season, and can collect four and a half tubs (equivalent to eighteen gallons), but the average receive 75 yen, and collect proportionally less. The present price per tub of lacquer ranges from 90 to 100 yen. After the sap has been taken, the exhausted tree, which remains the property of the seller, is cut down by him, and is used for firewood, for building purposes, or for making boxes.

The roots of the young trees throw from three to five shoots the following spring, and these can be used in six or seven years. Of these five sprouts three are commonly much stronger than the other two. In such cases, the strong ones only are tapped and cut down, the weaker ones being allowed a year or two longer to grow, when, receiving the whole of the nutriment, they shoot up in one year as much as an ordinary tree would in three. After tapping and cutting down, fresh shoots to the number of five, are again allowed to sprout, and so on, the root not seeming to become exhausted by the process; but when a very old tree is cut down, the roots will not give out new shoots. In the northern provinces very old and large trees are met with in considerable quantities. These were kept for the sake of their berries, from which the wax used for the Japanese candles were obtained.

This was the more profitable use to which to put the tree, as a good tree from 80 to 100 years old, yielded yearly, on an average, equal to 6s., while the price of a ten year old tree, to be used for extracting the sap, was under 1s. 2d. Previous to the Revolution of 1868, every tree reserved for making wax was officially registered, and the owner was not allowed to mutilate it in any way. Even if a tree died, he had to get official permission before removiug the stump. The Shogun's Government, and also the local magnates, had large plantations of the lacquer tree reserved for wax, but since the opening of the country to foreign trade, and the introduction from abroad of kerosene oil, the wax industry has greatly declined, and there are now no restrictions on the free sale of the tree for tapping, and, consequently, all the fine old trees (which will sell from five to six yen each) are fast disappearing.

To show the relative value of the berries and the trees a few years ago, the following may be cited:—A wholesale lacquer merchant informed me that five or six years ago he went, as usual, to purchase trees in the district of Aidzu, and among others bought one tree for a yen (then equal to 4s.), the owner reserving the berries that might be got as his own property. He does not consider the bargain was a cheap one, but the owner realised a sum of 80 sen (equal to 3s. 2d.) from that year's yield of the berries alone, before cutting down the tree.

It should be mentioned that the above description of the method pursued in tapping the lacquer tree is that which is recognised as the proper one, but the rule is not rigidly observed, the style and size of the tree, and the caprice of the workman, combining to cause variations in the number of incisions given in each series.

(*To be continued.*)

STRAW AS A SUBSTITUTE FOR WOOD.

The invention, by which straw is used as a substitute for timber, is an American one, and if the material fulfils all that is prophesied of it, it will probably interfere considerably with the timber trade. The following account has been published in America of this new substitute for wood. The straw timber is said to be adapted to many kinds of finishing work, panels, counter and table tops, fine doors, and ornamental work, and it is said that it can be produced and sold in competition with the finer grades of pine or wide walnut, at about one-half the price of the latter. The standard manufacture is in widths of thirty-two inches, a length of twelve feet, and a thickness corresponding to surfaced boards. These dimensions may be varied to suit such orders as may be given, and embrace any width, length, or thickness. Unlike lumber, however, narrower widths are the most costly. The straw lumber may be ripped with the hand saw, or upon the buzz saw; may be run through the sticker for the manufacture of mouldings, and takes a nail or screw as well as oak. It is, practically, water and fire proof, being manufactured under 500 degrees of heat, and it is stated to have stood boiling some hours without any apparent change of structure. Its tensile strength is greater than that of walnut or oak, and its weight about one-fifth greater than the former, when dry. It is made from any kind of straw, including hemp and flax fibre; in fact from any material that will make pulp, and a ton of straw will produce 1,000 feet of boards. The pulp is rolled into thin sheets, a number of which, corresponding with the thickness of the lumber desired, are placed together, with a peculiar cement, which is claimed to be waterproof, and are then rolled under a pressure sufficient to amalgamate them into a solid mass, which may be worked with a plane, if desired.

When it is remembered that it takes 100 years to grow a tree to maturity, suiting it for commercial purposes, and a tree producing thirty-two inch lumber will require fully twice that time; while 20,000 feet per acre is a large yield under the most favourable circumstances, it will at once be realised that where 2,000 feet can be taken from an acre of ground for an indefinite number of years, the process which enables such a result to be accomplished, and which will yield a really valuable lumber, should be one of great importance.

Correspondence.

PUBLIC HEALTH.

Assuming that Captain Douglas Galton's inaugural address is correctly reported in the abstract in the Society's *Journal* of October 6th, may I be permitted to ask two questions? First, in illustrating the self-cleansing power of rivers, it is stated that reference was made to the Seine, at Paris, which is black and foul when it leaves the town, becoming comparatively clear and full of water-plants and fish some ten or twelve miles lower down. I believe this result to be largely due to the mechanical process of subsidence, as demonstrated by the only too well known deposits of mud which take place wherever sewage is discharged into a river. This is not what we understand by "self-cleansing." It would, therefore, be interesting if Capt. Galton would kindly state whether, and, if so, on what grounds he assumes any self-cleansing action in the instance given beyond that of subsidence.

Capt. Galton is urther reported to have remarked:—"I am disposed to think that there has never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly, on analysis, have condemned the water as an impure source." Should this statement have been made after an inquiry into the circumstances attending the late epidemic at Caterham and Redhill? I have myself not been able to make a comparative analysis before and after the outbreak, but am informed by two different chemists that they failed to discover any difference in the water before and after, and, I may add, I am not aware of any evidence to the contrary. I do not mean to imply from this that chemical analysis is worthless as an indicator of danger. We have no better means of judging of the quality of a water, and a careful analysis will mostly give very valuable warning; but its value may be overrated, and is, in my opinion, overrated in the passage quoted above. Should I be correct in this, the important conclusions drawn by Capt. Galton can only be accepted with reserve.

GUSTAV BISCHOF.

Analytical Laboratory,
4, Hart-street, Bloomsbury, W.C.,
October 9, 1882.

General Notes.

SCHOOL OF ART WOOD-CARVING.—This school, in connection with the City and Guilds of London Institute for the Advancement of Technical Education, has reopened, at the Royal Albert Hall, South Kensington, S.W., after the usual summer vacation, and it is announced that free studentships, in both the day classes and the evening classes, are at present vacant. These studentships are maintained out of funds provided by the City and Guilds of London Institute. The school is open to amateurs, as well as to those who intend making wood-carving a profession. To those who are unable to attend the classes, information can be given by letter, and examples supplied. All necessary information, with forms of application and prospectuses of the school, may be obtained by personal application, or by letter addressed to the Manager, School of Art Wood-carving, Royal Albert Hall, Kensington, S.W.

SERICICULTURE IN HUNGARY.—The report recently published by the Government Commission for the development of silk-growing in Hungary, is analysed in the *Times*, from which it appears that during the last year there were 2,976 growers, who obtained 41,537 kilogrammes of cocoons from 426 parishes, while the sale of the produce realised 41,816 fl. This was a great advance on the previous year, when there were only 1,059 growers cultivating the industry in 109 parishes, and producing only 10,132 kilogrammes, which were sold for 11,062 fl. The present cocoon harvest has been sold to Italy for 63,000 fl., and the profits thus realised are being devoted to the establishment of a silk cultivation school, to which three training instructors are appointed by the Minister of Education, and three by the Minister of Commerce. Three other appointments have been made by private efforts, so that very shortly nine teachers will be available to travel through the country and give gratuitous instruction in the mysteries of silkworm rearing and silk-winding. In the model school of Goertz one of the professors holds classes for the surrounding district, and eighty kilogrammes of cocoons have been distributed to encourage beginners. The Government has also planted 28,956 mulberry trees. The report recommends the planting of mulberry trees on all the commercial lands and roads, in addition to the establishment of filatures in every district, and, if their recommendations are carried out, there is reason to expect that Hungary will become a great silk-growing centre.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

LABELS FOR PLANTS.

The Council of the Society of Arts offer a Prize of Five Guineas, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for a Wooden Plant Label, saturated with paraffin, or some other preparation which would preserve the label, and would be likely to keep the writing upon it legible, either with or without the aid of paint, for five years. The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

The labels will be tested by the Committee with the view of ascertaining, as far as can be done in a limited time, whether they would be likely to stand prolonged use. It is believed that satisfactory tests can be made in a month or two. Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society not later than the 1st June, 1883. The Council reserve to themselves the right of withholding the prize offered if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

CANTOR LECTURES.

BOOK ILLUSTRATION, OLD AND NEW.

By J. Comyns Carr.

Lecture II.—Delivered May 15th, 1882.

On the last occasion we discussed the conditions which should govern the relation of printed text and illustrated design. If the principles which I then sought to establish are admitted, it will follow that the earlier efforts of wood engraving exhibited qualities which most happily combine with the effect of type, and that the fuller, more complex, and more elaborate systems which have been introduced in modern times, whatever their merits from other points of view, have not the same fitness for the purposes of book illustration. But in the treatment of a subject like this, we cannot, unhappily, limit our view merely to what is best. The history of book illustration has historical as well as purely artistic interest, and it becomes, therefore, our task to-night to discuss those later phrases of the art which have arisen since what is known as the revival of wood engraving.

The immediate cause of the previous decline of the art was due, as I have already explained, to the preponderating influence of steel engraving. There were influences of a deeper sort which had affected for the worse all the arts of design towards the close of the 17th century; but there cannot be a doubt that, in so far as the special history of wood engraving is concerned, the practice of illustrating books by means of steel plates tended very greatly to effect its ultimate overthrow. It was not merely, as I have said, that the engraver on metal ousted the wood engraver, but that the practice of the latter became in itself injuriously influenced by the ambition to secure a kind of result which is wholly beyond his resources.

Before quitting the older wood engraving, it may be worth while to remind ourselves again of its special excellences; and, with this view, we may take a work which offers a supreme example of the beauty and elegance that may be secured by the very simplest technical means.

Last Monday I spoke of the "Ars Moriendi" as being not only the most admirable of the many block-books produced in the middle of the 15th century, but as offering, in itself, a sound example of style in regard to book illustration; and now I may, in like manner, point to a book produced in Italy in the last years of the same century, as expressing, in the highest form, the principles which the artist of the "Ars Moriendi" had enunciated. The designs of the "Dream of Poliphilo," published in Venice in the year 1499, will be accepted by those who share my views as to the requirements of book illustration, as a superb and unapproachable example of simple and dignified art. The original drawings have been sometimes ascribed to Giovanni Bellini, and whether by his hand or not, they certainly bear traces of the influence of that great master of design, Andrea Mantegna, with whom Bellini was associated. I remember, when I was in Mantua, inspecting a small manuscript volume, with drawings, said to be the work of Mantegna, which bore strong general resemblance of the work under consideration. But it would not be fair to insist too much on the original beauty of these designs, in reference to the subject we are discussing. If this beautiful volume is to be praised for the artistic invention which it displays, it is no less to be commended for the artistic method by which this invention is expressed. With scarcely greater elaboration than is employed in the "Ars Moriendi," but, with finer taste and greater skill, it presents to us a true reflex of the artistic resources of the time, and allows us to judge of the perfect instinct with which the book illustrator then observed the conditions under which he laboured.

But although it is the engraver rather than the designer with whom we are concerned, it must be observed that the two elements are so intimately connected, that it is impossible to keep them altogether separate and distinct. It is only a great art which can make simple means of expression suffice for its purposes. There is a vast mass of work now produced, work that powerfully impresses the spectator with a sense of the superior talent of the artist, which would not bear the test of translation into the simple and severe language of earlier design. The obtrusive realism of much of the modern wood-cutting quite as often serves to conceal the failures as to assert the power of the author to whom it is due. I do not wish at all to underrate the cleverness of much of the engraving that adorns the illustrated books and the illustrated periodicals of our time, but I do say that, in too many instances, the essential shortcoming of the design are covered and hidden by an elaboration of detail that has no value or significance, and that presents no real difficulty to the workman. I do say further, that if one of the talented draughtsmen who execute the drawings for the *Graphic* newspaper—and I am here taking a favourable example of modern wood engraving—were suddenly compelled to confine his technical method within the limits that were deemed sufficient to the illustrator of the "Dream of Poliphilo," his work would cut but a sorry figure in comparison. Where the means of expression are so simple, there is no way of escape for imperfect knowledge or uninspired invention; where the lines are so few, every line must have a definite meaning; and though the earlier artist seems at first sight to have achieved his end with much less labour, yet it will be found on closer study that he has expended more thought and reflection, and that he has brought to his task a finer sense and a truer science. Nor can it be said, with justice, that these earlier cuts are produced without reference to the peculiar requirements of wood engraving. The advocates of a more modern system are sometimes found to declare that these earlier engravings are only mechanical reproductions of pen and ink drawings, and that they show no special aptitude in the management of the material. But this is not so. The broad, firm line with which Durer and Holbein worked upon the wood can be produced upon no other material. It is essentially different from the line that can be cut or bitten upon the copper; and if this line is beautiful in itself, which I think no one who is familiar with the originals will deny, it is obviously unfair to say that the result has no claim to be ranked as a distinct and appropriate product of wood engraving.

With these two examples of early wood engraving fresh in memory, we will now proceed to consider the various modes of the modern wood engraver, as they are employed in the adornment of printed books. It is a matter of pride to ourselves, that the revival of the art should have taken place in this country; for I think it will not be disputed that the modern impetus which the practice of wood engraving has undoubtedly received, is due in great measure to the efforts of Thomas Bewick. In a certain sense Bewick may be said to be the inventor of wood engraving as a separate art, for he was the first to adapt himself with readiness and complete submission to the peculiar technical conditions which the woodblock suggests.

It may seem at first sight that this statement is in contradiction to what has already been said, as to the excellence of the earlier engravers; and it is, therefore, important that I should define clearly what is meant in thus ascribing to Bewick a position of such importance. The praise which has been bestowed upon the earlier engravings, is due to them in virtue of the completeness with which they fit themselves with printed books; but, of course, it would be unfair to allege that wood engraving must be altogether confined to the duty of illustration. It has a right, if it can prove its efficiency, to exist as a separate and independent art, and it is from this point of view that Bewick's influence is to be considered.

To my thinking, not even the best and most skilful of Bewick's cuts can be compared for beauty to the broad simple manner displayed in the "Ars Moriendi" or the "Dream of Poliphilo;" but when Bewick applied himself to the art, it had already passed far beyond the point at which it had arrived when these books were produced. A greater demand for completeness of pictorial effect had introduced a more elaborate system of workmanship, a system based, as I have already explained, not upon the peculiar conditions of the wood-cutter's craft, but upon the more or less slavish imitation of the processes proper to engraving on metal. It was Bewick's triumph to discover a means by which this greater elaboration can be more simply and more appropriately secured; and in order to understand the nature of this triumph we must remind ourselves again of the means by which a picture is produced upon an engraved block.

All earlier work, it must be repeated, was founded upon a direct imitation of an original drawing. Bewick's practice, on the other hand, consists in a direct use of the block itself; he was not in any sense a *facsimile* engraver. In order to explain his position in regard to his art, I may quote the words of a writer who has offered an enthusiastic vindication of Bewick's powers.

"Through the three centuries and a half," says Mr. Holliday, in an interesting series of articles contributed to the *Magazine of Art*, "which elapsed between the 'St. Christopher' and the time when Bewick began his artistic career, there is no sign that any artist who dealt with wood engraving recognised that the process consisted in cutting out lights, and that, by confining it to the imitation of black-line drawings, they weighted it hopelessly in its competition with other arts.

"If the view already expressed," continues Mr. Holliday, "be correct, wood engraving proper commenced only with Thomas Bewick, the work of this remarkable artist being in no sense a development of that of his predecessors, to which it is throughout opposed. Accepting as the obvious and unquestionably characteristic peculiarity of the wood-block, its unequalled power of giving clearly drawn whites on a dark ground, as contrasted with engraving on copper, which proceeds by engraving black lines on a white ground, we find first, that the earlier engravers ignored this capacity, but attempted such simple work only, that it was always easy to execute, though quite uninteresting when done. When they had such designs as these of Durer or Holbein to cut, the result was highly valuable; but, inasmuch as the engraver's work was purely mechanical, and left the resources of his material wholly undeveloped, his craft cannot be called an art. Instead of cultivating an art proper, he was imitating another art, that of pen and ink drawing on a material indifferently adapted to the purpose, his sole object being the production of many copies. It is quite clear that it never occurred to either artists or engravers that wood was capable of more than this. Secondly, we find, that Bewick discovered the true powers of the wood-block, and gives us, for the first time, engraving in which white is cut out of black, and where we find no attempt made to force the material into the unnatural imitation of scratching, cross-hatching, or any other mode for which it is unfitted; and, thirdly, we find that a great number of modern artists, who draw for wood, and engravers who cut the drawings, pass over Bewick's work and, recurring to the old, false, and hopeless principle of imitating other and antagonistic arts, aim exclusively at qualities in which wood is infinitely surpassed by etching, and leave untouched those in which etching would be as completely outstripped by wood engraving."

According to Mr. Holliday's contention, Bewick's perception of the capabilities of the wood-block is based upon an essential principle in the rendering of nature. "A little reflection," he says, "or, what is better, a little observation, will show us that nature, as a rule, exhibits objects light on a dark ground;" and he therefore proceeds to contend that that process will have the advantage in which lines are taken out with the greatest ease, in which the objects are drawn with light instead of being drawn with darkness. I am not disposed to contest Mr. Holliday's generous estimate of Bewick's genius. Assuming that wood engraving is to exist as an independent art, he is, I think, unquestionably right in asserting that Bewick was the first to perceive the true means by which the block might be utilised for this purpose. In so far, then, as it may be regarded as a direct means of artistic expression, the conclusion we should seek to establish may be said to be uncontrovertible, for it is obvious that the distinction so often insisted upon between the processes of wood engraving, or the processes of etching or engraving on copper, suggests a very important difference in the manner of working.

It is this fact which leads Mr. Linton, the eminent living professor of the art, to declare that all true wood engraving is produced by the use of what he terms the white line. If, therefore, we suppose the case of an artist working directly from nature upon wood, we may readily acknowledge the method described by Mr. Linton and Mr. Holliday to be the most appropriate to the means at his disposal; but, as a matter of fact, wood engraving has very rarely been used as a means of independent expression; the causes which have determined the use of this particular process are of a practical rather than of a purely artistic character. The wood-block offers the readiest and the most economical mode of multiplying copies of a design, and it is for this reason that it has been so constantly employed for the illustration of printed books. If the larger principle for which Mr. Holliday contends were true at all, it would hold good as well for the draughtsman as for the engraver, and we might, therefore, expect that drawings would, as a general rule, be executed with a white pencil upon black paper. It is obvious, I think, that to accept this logical inference would be to place the pretentions of the wood-engraver upon too high a pedestal. The practice originated by Bewick must be taken as indicating a convention necessary to the art, as he understood it, but having no basis in a deeper principle.

It was a happy inspiration which led Bewick to perceive that a harmonious and consistent result might be produced, at an expenditure of less labour than earlier engravers had been forced to bestow. His art, as he practised it, is not an art of reproduction or imitation; it is essentially a means of expression, and in his blocks we get the first independent experiment to give to wood engraving, by means strictly appropriate to the material, the force and variety of tone that we find differently expressed in a painting or an engraving on copper.

Bewick's blocks are, within their limits, complete as pieces of pictorial illustration; they do not suggest the existence of any drawing in another material from which they have been copied, nor, on the other hand, do they convey the idea that the artist has been attempting to reproduce the effects of a work in colour. Since his time wood engraving may be divided into three distinct categories. There is first a style developed from that which he originated, and which depends upon a wholly independent treatment of the wood-block. Secondly, there has been, as I pointed out in my last lecture, a developed style of *facsimile* engraving, not different in principle from the earlier manner, but admitting greater variety of effect, and simulating with more adroitness the individual manner of an artist's sketch. Thirdly, we have a great mass of modern wood engraving which applies itself to the task of imitating the appearances and results of other arts, either in painting, drawing with the brush, or in sculpture.

Let us now consider these different styles in their order. Bewick's method, in the most familiar and celebrated examples of his work, consist not in the use of lines at all, but in the cutting away of irregular spaces. He works from the black surface of the block, with a desire to retain of it as much as possible; and he therefore expresses himself less by definition of line, than by contrasted masses of light and shade. In fact, to quote again the words of Mr. Holliday, "the picture is drawn in white, upon a black ground, and his blocks are executed in such a way as to suggest that he he had previously made a drawing in this manner."

This mode of work has its counterpart among the processes employed by the engraver on metal, in what is known as mezzotint engraving. Here, as you are aware, the whole surface of the plate is ploughed up, so that, when filled with ink, it produces a uniform impression of the deepest tone. Upon this dark background the engraver then proceeds to register his picture by scraping away the lights. In proportion as he restores the even surface of the plate, he secures the highest light, and by graduated strength of execution, he is able to represent, with the utmost subtlety, all the most delicate refinements of light and shade. The same subtlety and refinement are not possible to the wood-engraver, but it is possible to work upon the same principle; and it was this principle which Bewick's genius enabled him to apprehend. In the representation of objects in nature, an artist may proceed either by mass or by line. He may first define the forms, and then afterwards add, by successive lines, the sense of contour and solidity; and in work so produced it will always be easy to perceive that the bounding lines of the picture have been established first, and that the truths of tone, which give roundness and reality to the picture, have subsequently been added. Or he may, if he chooses, proceed at once to translate the appearances of nature by careful disposition of masses of light and shade, and then, according to this system, the outline will come unsought as the result of contrasted strength of different depths of tone. It was in the use of this particular method that Bewick's originality is most clearly displayed. He cannot be said to have absolutely discovered the idea of working in white on black, for some of the initial letters in the earlier printed books of Italy are executed upon the same plan; and in the print room of the British Museum there are one or two large wood engravings of the human figure which display a like perception of the facilities which the wood-block offers for such a mode of work. But Bewick, if he did not absolutely originate the style, nevertheless uses it with the happiest effect in his careful and elaborate engravings of animals and birds. Nothing could be more admirable than the skill with which he conveys the sense of delicate tone and texture of a bird's plumage; and it is remarkable that the realism which attaches to this part of his work is often strangely in contrast with the crudely executed details of background.

But there is another class of engravings by Bewick, in which a different method is pursued. In treating landscapes, he proceeds really upon a totally distinct principle to that which guides him in his more careful and elaborate rendering of animals. Here his endeavour is not merely to register form, or even to simulate effects of texture, but to indicate the impression of a tint, and this he does with superb skill, by the use of what Mr. Linton has called a white line. By varying the thickness of the lines that he cuts away, and therefore conversely of the line that he leaves, he succeeds in giving every variety and delicacy of tone.

This is the phase of Bewick's art which may be said to have been most fruitful, by way of example to more modern engravers. The originality of Bewick's achievement is the more remarkable, seeing that there is nothing in the circumstances of his education which could, in any way, have assisted his progress. Having at an early age exhibited a certain taste for drawing, he was apprenticed by his father to Mr. Ralph Beilby, an engraver, to whom he was bound for a term of seven years; but Beilby was an engraver on copper, and for some time the young Bewick was employed in the rougher sorts of copper-plate work, even including the execution of brass-plates for street-doors, and of crests, and initials on watch seals and silver plate. At the expiration of his apprenticeship he seems to have formed a resolution to apply himself altogether to wood engraving; and it is noticeable that his earliest essays prove that he had not yet abandoned the traditions which belonged to his practice as an engraver on copper. But it was not long before he struck out a new path of his own, in which he showed that he had reflected for himself upon the resources of his art, and that he brought to its practice not merely manual skill and dexterity, but individual artistic power and an individual technical style.

I shall not dwell at length upon that particular manner employed by Bewick, which consisted, as I have said, less in the use of lines, than of masses of light and shade. It has not yet been fruitful in any remarkable development among later engravers, though it is clear that in the hands of a man of distinct gift, it might be made to yield new and interesting results. That it could ever take a foremost place, as a means of interpreting nature, is not to be said, for it would always be necessary to acknowledge and accept a distinct convention upon which it is founded.

A far more important influence on wood engraving may be traced to Bewick's use of line. Here, also, his practice shows a due regard for the limitations of wood engraving, and it has been found capable, in other hands, of producing work of singular excellence and refinement. In its essence, this style of engraving may be said to be the converse of that which was employed by the earliest artists; they laboured with a view to producing effect by the use of well-defined black lines, in rendering the impressions of an original drawing. Here, on the other hand, the picture is traced by means of cutting away regular white lines of varying thickness, so managed, as to show that the artist has worked with the peculiarities of a wood-block constantly in view. It is among the modern engravers of France that this system has been adopted, and pursued with the greatest measure of success. An artistic result always gains in effect of dignity and charm, when a certain degree of scientific system and precision are seen to be employed in its production. No device, however cunning, will give a picture that peculiar fascination which comes from the perception of a style firmly held and deliberately put in practice; and it would be hard to match, even amongst the most perfect *facsimile* engravings, the beauty of certain wood-blocks produced by some of the modern masters of the French school. As a favourable example of this method, I may take a reproduction of an early Florentine picture by Pannemaker, a copy of which I have brought with me to-night. Here it may be observed that the engraver has been, in the first place, careful of the qualities of the work that he has been called upon to translate. There is something in the simple and restrained style of the engraving, which accords with the *naïve* manner of the painter. Assuming that it is fair to attempt in black and white to make a version of a work in colour, it would be difficult to conceive of any better spirit in which to approach the task than Pannemaker has here displayed. In the next place it may be said that the engraving has a special charm, inasmuch as it appeals to us confessedly as a work executed on wood.

There is no merit in art in any concealment of the means by which a good effect is produced. If we are looking at steel engraving, we like to feel that the engraver has made full use of all the delicate resources at his command, and that he has denied himself no refinement or subtlety of tone which the material places within his reach. In like manner a wood-block should give us a pleasurable sensation, by reminding us of the peculiar advantages which it offers to the artist.

We like to feel not merely that the work is admirable in result, but that it has been a pleasure to the workman, and that he has enjoyed the task of accommodating his subject to the particular means at his disposal. We like to feel also, and we do feel always in the presence of any piece of masterly art, that the artist has had no unequal struggle with difficulties hard to overcome, but that he has been able, by his knowledge and practice in the craft, to bring a definite system to the treatment of the whole. In looking at a fresco, one element of fascination depends upon the fact that the texture of the wet plaster partly overpowers the surface of the colour, and hinders any impression of vulgar illusion, by reminding us that it is a picture painted on a wall. In the same way it is pleasant, in a wood engraving, to feel that it is a wood engraving, and that the lines are traced by one who is familiar with the processes, and who is not afraid to adapt his subject to his material. Nor is it to be said, because there is no attempt at any striking imitative effects in texture or colour, that the work is wanting in subtlety or skill. It is easy to perceive that these lines of varying thickness, through which the face of this maiden reveals itself, are cut by the hand of a master; every part of the picture has an equal degree of realism, an equal suggestion of colour, and yet there is over all a prevailing sense of style and system which gives the result its peculiar charm. It would be easy to multiply examples of the modern French school, which show to what a high point of development this scientific manner of wood-cutting has been carried, and we must acknowledge, when we look to the work of the past, that this mode of wood-cutting is a new discovery, and that it undoubtedly has its origin in the work of Bewick.

I have brought this evening, among several examples of modern engraving, another block, which shows how the same manner may be applied to the rendering of a work in sculpture, and I think it will be admitted that these specimens are in many respects superior and more enjoyable than the most dexterous feats of realistic interpretation. In both it will be observed that the engraver's feeling for his own art is uppermost. He has not treated the statue in such a way as to give us any idea of the accidents in the surface of marble; nor in the engraving from Granacci is there any attempt to imitate the surface of a painted panel. They both tell at a glance as wood engravings, and yet in both there is such a feeling for the subject, as makes us acknowledge that the originals have been appropriately and fairly translated. Of a second style which has prevailed since Bewick's time, viz., that which is founded upon a *facsimile* reproduction of a drawing in pen and ink. I have also brought examples, but of the style something has already been said; and I may, therefore, proceed to the third division, under which I have classed modern wood engraving, and which, in the place it occupies at the present time, may be reckoned perhaps the most important of all. It was doubtless from the practice of *facsimile* wood-cutting, that the thought has occurred to modern artists that it may be possible to imitate on the wood-block other and more elaborate effects; and it has been left to the modern engravers of America to show to what a point this experiment can be carried.

You are, many of you, I have no doubt, familiar with the very delicate and elaborate cuts to be found in the pages of the principal American magazines. It cannot be truly said that the process, or rather the manner here employed, owes its origin to America, for among the continental artists there are several instances where the same kind of result has been achieved; and I have brought, this evening, some specimens of French engraving, which are certainly extraordinary samples of the manual dexterity which can be shown in the treatment of this class of work; but it is in America that the style to which I have referred has been followed with the greatest audacity, and, in some instances, with the greatest success. American engraving, in its latest phases, claims to be no more than a process of imitation and reproduction; and in judging of the results which it offers to us, we must put aside all earlier principles of the art. On the other hand, there is no attempt, such as we have noted in the older engravers, to fit the result to the uses of book illustration.

The association between the block and the literature which accompanies it, so far at least as appearances are concerned, is purely accidental. Of course, the engraving may explain the text, and the text may explain the beauties of the engraving, but that decorative charm which belonged to the book of an earlier time is now wholly forgotten and neglected, or is, at least, never secured. On the other hand, we must equally put aside those principles of style which may be said to have taken their origin in the work of Bewick. These blocks leave no special or peculiar character as wood engravings. At one moment we are called upon to admire the adroitness and skill with which the artist has imitated the texture of a painted tile; at another we admire the dexterity with which he has reproduced for us the faded surface and the worn lines of one of the drawings of the old masters; then, again, it is the brush work of a modern oil painting that he seeks to reproduce for us; or, again, with no less skill, it is the warm tone and blurred line of a dry point etching that he transfers to his block.

I have brought with me to-night a number of specimens of these modern American wood engravings. You are, perhaps, aware that its processes have been assailed with some asperity by representatives of the more conventional school. A fierce controversy has been going on between these artists and that veteran engraver, Mr. Linton, to whom they, in turn, doubtless owe much of their instruction. Mr. Linton has no faith in the new movement, he denounces the liberty which many of the younger men allow themselves, and he regrets the recent attempts that have been made to reproduce varied effects of tone and colour, and to imitate the different modes of execution in pen, brush, or charcoal, as a waste of time and a wanton perversion to skill and labour. It would take too long to follow Mr Linton in all the details of criticism, nor is it necessary for our purposes to do so; the point which he seems to miss is that wood engraving in its modern acceptation is of a wider scope than he would seem disposed to allow. It is idle, at this time of day, to attempt to confine wood engraving within the limits of an original art. A process which offers such facilities in regard to reproduction must, of necessity, be employed in a vast variety of ways, and there seems to us to be no reason in the nature of things why one school of workmen should not take the course which the American engravers have followed. An experiment of this sort must be measured by its success; nor can it be gainsayed that these younger engravers of America have in this respect more than justified their departure from the accepted rule. So closely does the work accord with the original it has undertaken to imitate, that I have often heard it asserted, even by artists, that these American wood-blocks are in fact not wood-blocks at all, but are mechanical reproductions of drawings or paintings. Of these mechanical reproductions I shall speak more at length in my next lecture, but although these American illustrations are genuine works of wood engraving, there would seem to be little doubt but that the efforts of their authors have been largely stimulated by the success with which various mechanical processes have lately been developed.

That a wood engraver, who has faith in his art as a dignified means of original expression, should regard with dislike the kind of dexterity which this younger school has acquired, is conceivable enough, but the truth is that these pretentions which Mr. Linton and others are now making, are of quite recent origin. In all its past history, wood engraving has been a recognised method for reproducing original work. When the propriety of *facsimile* engraving is once admitted—and *facsimile* engraving, it may be remembered, is the very earliest and worthiest form of the art—the accusations brought against the younger school will be found to lose half their force.

Their practice is nothing more than a development of a principle that has been tacitly acknowledged since the craft has been in existence, and as the earlier workmen strove to reproduce faithfully the simple lines of the design, so they now endeavour, by greater variety of method, to copy exactly the effect and colour of the original drawing. The degree of success which they have attained can only be judged by reference to particular examples; but their efforts would certainly have missed success if they had allowed themselves to be hampered by the rules which Mr. Linton, and those who think with him, now seek to impose upon the art. The principle that may be said to characterise all the work of the school, springs out of a single desire to preserve the character and appearance of the work chosen for reproduction; and with this work steadily in view, the engraver permits himself to make use of devices which are often in conflict with the conventional kind of execution hitherto employed. That these devices are, in many cases, experimental, is frankly acknowledged; but no one who studies these blocks attentively can fail to perceive that such experiments have been the means of enriching the resources of the art. Now and then their endeavour to do justice to the original artist may result in a failure; but this failure is more than counterbalanced by many successes, and by the strong impress of personal and individual style which the experiment has gradually developed. The engraver, it will be seen, begins to acquire and to practice a system of his own, by which he is enabled to infuse into his work a new sense of variety, and to claim for it a kind of attention and interest, such as could never be allotted to the strictest adherence to a rigid rule of procedure; and it may be said, further, that in the hands of the most gifted of these American engravers, a sense of style is gradually asserting its control over the newly acquired methods.

I may point, in particular, to the work of Mr. Cole, as it is shown in the pages of *Scribner's Monthly Magazine*. The block, for instance, in which he has reproduced the noble picture of "The Sower," is executed in a manner that has nothing discordant with the principle that Bewick established. Where the simple line can be used as, for example, in the treatment of the sky, the artist has shown his willingness to adopt that mode of treatment; and although the whole effect of the block is delicate and refined, there is an admirable economy of method in the way in which the dark sombre figure is relieved against the dark hill-side.

These essays of the American engravers present, as I have said, nothing that is antagonistic in principle to the practice of Bewick. Their method is founded, like his, rather upon the rendering of mass than upon severe definition of line, and the differences between the two are differences of detail. And yet these differences, it must be allowed, are not unimportant. Though Bewick, in his admirable cuts of British birds, did not insist upon outline, he always adopted a regular and uniform system of execution. He worked with line, even while he was endeavouring to secure effect of tint; and it will be seen that although he makes use of the black surface of the block where he can give the sense of dark colour, yet the lighter tints are always produced by delicately-cut lines which have a rhythmical and regular direction. The majority of the American engravers do not confine themselves to this method. If they want to relieve or lighten a dark surface, they as often as not pick out the lights in small irregular holes. They stipple, so to speak, with the point of the graver, and their work has, for this reason, more of the appearance of accident and less of the method of art. And it must be said further that they are greatly assisted by the mechanical appliances of printing which were not within Bewick's reach. The printing of wood-blocks in America is itself an art, and much of the beauty of the wood engravings depends upon its exercise.

I have now traced, very briefly I know, and very inadequately, the history of wood engraving since its first appearance in the 15th century, and it may be worth while to summarise the direction of its progress, and to note how far its modern developments have fitted it for the particular conditions of illustration, which it is chiefly called upon to discharge. In the beginning, as we have seen, the wood engraver was an engraver in *facsimile*; he sought to express original designs executed by artists who were constantly mindful of the limited resources of his art, and the particular conditions under which their work was to be associated with printed books.

As the effects within the reach of the wood engraver became gradually more complicated, the professors of the craft were overtaken by a desire to compete with engravers on metal; and no sooner was this competition fully established, than the use of metal plates for book illustration resulted in the final overthrow of the wood engraver's art. In its revived form, as we have seen, wood engraving took a new departure.

The man to whom its revival is chiefly due was not only a skilful draughtsman, but an original artist of power; and he, therefore, began to use the wood-block, not with any special reference to its place in a printed book, but rather as one artist might use the copperplate, merely as the material for expressing his own inventions. Thus it happens, that in spite of the beauty of Bewick's designs, they have no special charm in connection with the subject we are discussing; they have led to the discovery of new resources in the art itself, but they have not provided us with any adequate substitute for those simpler blocks which adorn the books of an earlier time. In the hands of later artists, who have made use of Bewick's discovery, wood engraving may be said to have reached its furthest limits of development. It is difficult to conceive that in pure engraving we can get better results than are to be found in such a block as that of Pannemaker, which you have seen to-night; and it is impossible to believe that, as a means of imitation, it can be carried much farther than the point already reached by the engravers of America; but all this development has not greatly helped to give greater beauty to printed books; and now that the whole scope of the art has been shown, and that all possible discoveries have been made in all the technical departments of the art, it may be worth considering whether the time has not arrived, as a matter of taste and beauty, to revert to that earlier style, which I discussed last Monday. This I think, at least, is certain, that, unless the wood engraver and the artist who works for him are willing to labour in this direction, he will before long be ousted altogether by the many mechanical processes dependent upon photography which are used for the purposes of illustration. The discussion of these processes, and of their use to printed books, I shall reserve for my next lecture.

Miscellaneous.

THE MANUFACTURE AND PREPARATION OF JAPANESE LACQUER.

(Continued from p. 1043.)

Various Woods Used in Making Lacquer Ware.

The woods chosen for lacquering on are naturally selected according to the use to which the lacquered article is to be put. For shelves, cabinets, boxes of all kinds, the following are principally used, and are set down in the order of their excellence:—*Hinoki* (*Chamæcyparis obtusa*).—This is by far the best wood for making boxes, as it does not warp. *Kiri (Paulownia imperialis).*—A light wood used for clothes boxes, which are only lacquered on the outside. It is also used for making tea-caddies, as the wood has no smell. *Hōno-ki* (*Magnolia hypoleuca*).—All sword sheaths have hitherto been made of this wood. *Sawara (Chamæcyparis pisifera).*—This is a wood of a coarser grain than *Hinoki (C. obtusa). Hime-ko-matsu.* — This wood is used for carved figures of men, animals, &c. It is not liable to split and crack. *Tsuga (Abies tsuga*). *Hiba (Thujopsis dolabrata).* — Used for making cheap articles. *Akamatsu (Pinus densiflora). Sugi (Cryptomeria japonica).*—This wood is only used in making the cheapest and most inferior goods.

The following woods are mostly used in the manufacture of such articles as are turned in a lathe, as bowls, rice cups, round trays, &c.:—*Keyaki (Planera japonica).* — The best being obtained from the province of Hiuga. *Shoji*, the scientific name of which is unknown. *Sakura (Prunus pseudo-cerasus). Katsura (Cercidophyllum japonicum). Tcho (Gingko biloba). I-go.* — Grown in large quantities in the neighbourhood of Hakone. It is principally used in the manufacture of cheap articles. *Buna.*—Principally used in the district of Aidzu for the same kind of utensils as Keyaki and Sakura, but being a brittle wood, it cannot be turned in a lathe to make such fine articles; those made of this wood are coarse and heavier. For raised gold lacquering over unvarnished surface, the following hard, ornamental woods are often used:—*Shitan*, *Tagayasan*, *Karin* (quince), *Kuwa* (mulberry), *Keyaki* (*Planera japonica*), ornamental grain.

Various Kinds of Lacquer and Mixtures Used.

(A.) FOR PLAIN WORK.

Ki-urushi (crude lacquer) is the generic name by which all lacquer obtained from the trunks of live trees is known. It forms the basis of nearly all the various mixtures used in making lacquer ware.

Seshime (*branch lacquer*).—This kind is obtained from the branches of the trees, as described above; but the yield is only 1 per cent. in comparison with other lacquer. As, however, in working, the proportion of nearly 90 per cent. is required, the lacquer manufacturers sell a mixture which is stated to be a compound of true branch lacquer, the best crude lacquer, *ura-me* and *tomé* lacquer, funori (seaweed jelly), sweet potatoes grated fine, the whole coloured as may be necessary with soot. The proportions in which these materials are used cannot be ascertained, and indeed each manufacturer uses his own special mixture, but the extraneous additions are believed not to injure the quality of the whole. True branch lacquer becomes extremely hard when once dry, but used alone will not dry under some twenty days, so that now, when time is an object, the pure sap is but little used.

Previous to the Revolution of 1868, branch lacquer of a very superior quality, and which would dry quickly, was obtained by using the young shoots which sprouted yearly from the roots after the trees had been cut down. This kind was called Kiseshime (crude branch), and was made under directions of the Government, who received it as taxes, but the practice has been discontinued of late. The price of pure branch lacquer is, owing to the difficulty in drying, only 70 per cent. of ordinary good lacquer.

Rō-urushi (*black lacquer*).—This is made by adding crude or branch lacquer, about 5 per cent. of the tooth dye used by women (haguro), a liquor formed by boiling iron filings in rice vinegar, and exposing it to the sun for several days, stirring the mixture frequently till it becomes a deep black.

In preparing all lacquer—from the crude lacquer to the various mixtures—the principal object is to get rid of the water that exudes from the tree with the sap. To effect this it is exposed in broad, flat wooden dishes, and stirred in the sun. This, however, alone will not cause the original water to evaporate, so from time to time—ordinarily about three times in the day —a small portion of clean water is stirred in, say 1 per cent. each time, for a couple or three days, according to the heat of the sun. All the water then evaporates together. No lacquer will dry until this process has been gone through. It the lacquer is old, *i.e.*, has been tapped a long time before using, it is much more difficult to dry. In such a case a portion of fresh lacquer is added to the old by wholesale dealers, or else the manufacturers, instead of water, sometimes mix saké (rice beer) or alcohol to "quicken" it.

A very remarkable property of lacquer should be mentioned. If crude lacquer, which is originally of the colour and consistency of cream, is exposed to the sun for a few days without adding water, it loses its creamy colour, and becomes quite black, or nearly so, but also becomes thinner and transparent, or rather translucent, as can be seen when it is smeared on a white board. It will not now, however, dry if applied to an article, even if kept a month or more in the damp press. But if water is mixed with the lacquer which has thus been exposed and become black, it at once loses its black colour and transparency, and becomes again of a creamy colour, though slightly darker, as if some coffee had been added, than at first. After evaporating this water, it can then be used like any ordinary lacquer, either alone or in mixtures, and will dry in the damp press, during which process it again turns black. What lacquer workers have found their greatest stumbling-block is the difficulty of obtaining a clear, transparent varnish. What is called transparent varnish is really black to the eye, and requires grinding and polishing after application before it presents a brilliant surface, becoming also much lighter after a little time.

It would be a new era in the manufacture of lacquer ware if a method could be discovered of rendering the lacquer varnish perfectly clear and light-coloured, when so desired, without depriving it of its drying qualities, and also if colours could be used with it other than those hereafter mentioned.

(*To be continued.*)

General Notes.

AMSTERDAM INTERNATIONAL EXHIBITION.—A public meeting is to be held at the Mansion House, on Monday next, at 3 o'clock, to receive the London Honorary Committee, and to report progress made in the British Section.

A CENTRAL ASIAN RAILROAD.—It is stated in the Geographical Society's proceedings that a report by M. von Schültz has been recently laid before the Imperial Russian Geographical Society, on a survey, made by order of General Struve, along the proposed south-eastward extension of the Orenburg railway, and the result is to show that the best line is by way of the valley of the Ilek, across the southern part of the Mugodjar hills to Tetse-bash Bay, on the north-western shores of Lake Aral. Another party at the same time starting from Kara-Turgai and Kazalensk, and working across the Karu-Kum desert to the north-west, examined the country east of the Great Barsuk sands; but this was found far less favourable than the Tetse-bash line, which is better populated, has more water, and a better supply of materials requisite for the construction of a railway; it is only 480 miles in length, terminating at Tetse-bash Bay, which makes a good harbour, while from the sea of Aral, the rivers Oxus and Jaxartes are navigable for the distance of 1,600 and 1,300 miles respectively.

NEW ZEALAND COAL MINES.—Among the coal mines rapidly being developed in New Zealand, is one situated near the town of Westport, on the west coast of the Middle Island, which is distinguished by two remarkable, if not unique, features, viz., the thickness of its coal seams, which range from 6 feet to 53 feet 6 inches in thickness; and the fact that these enormous deposits are placed, and can be easily worked at an altitude of from 800 feet to 3,000 feet above sea level. Some of these seams are exposed on the faces of the cliffs, and can be got at with the greatest ease by tunnelling. Besides the comparative immunity from ordinary accidents which this remarkable disposition of the coal deposits affords, there is the further advantage that the mines are absolutely safe from flood, and almost, if not quite, secure from the risk of explosion from fire-damp. There is the further advantage that the coal can be loaded on board ship by gravitation, the danger and expense of hauling the coal up a deep perpendicular shaft being entirely avoided, while the full trucks can be made to convey themselves down the mountain slope to the harbour, and, at the same time, haul up the empty trucks along a parallel line of railway, on the ingenious system adopted at the celebrated stone quarries at Portland, in Dorsetshire.—*Times.*

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The arrangements for the one hundred and twenty-ninth session of the Society have now been made by the Council, and full particulars will be printed in the next number of the *Journal*.

The first meeting will be held on the 15th November, when the opening address will be delivered by Charles William Siemens, D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas, there will be five ordinary meetings in addition to the opening meeting. Candidates proposed for election as members are privileged to attend the opening meeting.

There will be five courses of Cantor Lectures during the session. The first course, on "Dynamo-Electric Machinery," by Professor Silvanus P. Thompson, D.Sc., will be delivered before Christmas.

The two Juvenile Lectures at Christmas will be by Professor Henry Nottidge Moseley, M.A., F.R.S., on "The Inhabitants of the Ocean." Announcement of the arrangements for these Lectures will be made in due course.

Proceedings of the Society

CANTOR LECTURES.

BOOK ILLUSTRATION, OLD AND NEW.

By J. Comyns Carr.

Lecture III.—Delivered May 22nd, 1882.

Having traced the progress of wood engraving in its latest and most extreme development, it becomes our task to-night to consider those various mechanical processes that now place themselves in competition with the engraver's art. That these processes should already occupy an important place as a means of book illustration is scarcely remarkable, seeing that they can be employed at a cost very much lower than is required even for the commonest and coarsest wood-blocks. That they do not yet display an equal refinement and perfection in the rendering of an artist's work, must indeed be allowed, and there is still a certain superiority possessed by the wood-block which had not been attained by any of the mechanical processes; but that this superiority will be preserved, it would, I think, be rash to assert. Within the last few years, nearly all these different processes have been developed with remarkable rapidity and success, and I believe it probable that, before long, results will be obtained such as even the most delicate wood-block cannot rival. All these processes, as you are doubtless aware, have been the outcome of the invention of photography. For some time there was a disposition to use direct photography for book illustration, never, I think, with very fortunate effect. The appearance of a photograph has absolutely nothing in common with that of printed text, and it is impossible to combine the two so as to produce a satisfactory or harmonious result. Direct photography then, as a means of book illustration, scarcely deserves consideration; but although a volume adorned with photographs can never be a very lovely object, the attempt to make use of photography for this purpose, has led to valuable discoveries, which have been fruitful in other directions. Perhaps the most important of all these discoveries, was that by which the photographer was enabled to obtain, from the negative, a print that should be permanent and indestructible.

The carbon print never exhibits all the refinement and delicacy which belongs to the silver print; but the fact that it is indestructible, and that it may be produced in any tint or colour that is desired, gives it a special value of its own. You are no doubt familiar with the marvellous reproductions of drawings by the old masters which have been made by Mr. Braun, of Dornach, and which are printed by the carbon processes. When you have no original at hand, it is difficult sometimes to believe that the photograph itself is not the drawing, and it would certainly be impossible to find any means more suitable for the reproduction of this particular class of work. This carbon process is constantly employed in the illustration of books under less advantageous conditions. A way has been discovered of multiplying the carbon prints mechanically, and, in certain instances, the results obtained are sufficiently good; but, as a rule, this process gives but a poor and lifeless copy of any work of real art. If the original drawing be in line, the lines as they re-appear in the print lose much of their force and vigour, and in all cases the surface of the print has a dull and lifeless appearance, and much of the refinement of tone which may be secured in the original negative is altogether lost.

I shall not, however, attempt to compare or to discuss the different modes of producing these photographic prints. I have referred to the carbon process because it really forms the basis of one of the most interesting and admirable of the many modes of photographic engraving. Hitherto, in speaking of book illustration, I have limited myself to the art of the wood engraver, but as these mechanical processes are equally applicable either to printing in relief or in intaglio, I shall bring to your notice specimens in both kinds, and briefly explain the means by which they are produced. Perhaps the very finest examples of mechanical engraving are those which bear the name of Mons. Amand-Durand, of Paris. The reproductions which he has published of the works of Dürer and Mantegna, and of other of the earlier masters of engraving, are of unapproachable beauty and excellence. I have heard Mr. Reid, the accomplished and learned keeper of prints and drawings at the British Museum, declare that it is almost impossible, in some instances, to distinguish between the copy and the original, and certainly to those who cannot possess the originals these plates of Mons. Amand-Durand offer a delightful substitute. Of the manner in which they are produced I cannot speak with any authority. That it is based upon photography is of course certain, and it is mainly, though not wholly, mechanical in its operation. Mons. Amand-Durand is a skilful engraver on metal, as well as the inventor of this wonderful process, and there is no doubt that he supplies, with his own hand, any deficiency that may exist in the plate as first produced. But although these plates are certainly the most perfect of their kind, they deal, for the most part, with only a special class of work. As a general rule, Mons. Amand-Durand limits himself to the imitation of engravings in line, and he has not, save in a few instances, tried to reproduce the effect of a chalk drawing or of a drawing in wash. In this sense, therefore, the process employed by M. Goupil has a wider scope, and this has its English counterpart in the invention of a similar kind made Mr. Henry Dawson. One of the very first set of plates produced by Mr. Dawson, after his invention had been perfected, consisted of a series of copies from drawings by the old masters, which are published in the catalogue of the Grosvenor Gallery. I have brought them with me to-night, and although I do not doubt that Mr. Dawson can now do much better than this, I think you will admit that they are, in certain respects, astonishing examples of imitative skill. Mr. Dawson makes no great secret of the principle on which his process is founded, and I may therefore briefly explain to you the ingenious mode in which this admirable result is obtained. You will observe, in the first place, that these are impressions from metal plates, printed in the same manner, and by the same press, as a copper or steel engraving, but instead of the picture being engraved upon the plate, as one might expect, the plates are, themselves, so to speak, produced upon the picture. It is the picture, in Mr. Dawson's process, which really creates the plate; and the way in which this is accomplished is so remarkable, that perhaps you will allow me to give a few words of explanation. The first thing that Mr. Dawson does, after having photographed his subject, is to take from his negative a carbon print; this print is taken, not on paper, but on glass; and as the principle of a carbon print consists in the deposit of solid pigment, the picture so taken upon the glass represents a very delicate work in relief; that is to say, the surface of the picture is very slightly raised upon the smooth surface of the glass. This impression is then covered with a thin coating of gold, which acts as a powerful conductor of copper, and the glass is now placed in a galvanic bath, where the copper is gradually deposited over the whole of the plate. When the deposited copper has attained a sufficient thickness, it is taken from the bath, and the glass is removed. We then have a copper plate with the picture cut upon its surface, exactly corresponding to the carbon print; that is to say, those portions which in the print were in relief, are now in intaglio, and every delicate gradation is exactly reproduced as in the original negative. The copper-plate now resembles, in every respect, the work produced by the engraver. According to the character of the original, it partakes of the nature either of an engraving in line, or of a mezzotint engraving, and it is this quality of mezzotint surface which Mr. Dawson rightly regards as constituting the special claim of his invention. The difficulty here with which he had to contend was to give such a surface as would hold the ink, and this he has now accomplished in a very remarkable degree. A certain amount of hand-work must occasionally be added, in order to correct the defects of the photograph, which sometimes gives undue force to the delicate portions of the original drawing; but broadly speaking, the process is purely and wholly mechanical, and the copper-plate, as we have seen, is absolutely grown upon the raised print. There is scarcely any kind of original work to which this process may not be applied with success. In the reproduction of a drawing in pen and ink, the result resembles a strongly bitten etching. It is equally successful in imitating the effect of a drawing washed with a brush, or of a drawing in chalk; but as deposited copper is always more or less soft in substance, the plate, before it is used by the printer, is covered with a thin film of steel, and we have then a surface which is practically indestructible, and from which any number of impressions can be taken, for so soon as this thin film of steel shows signs of wear, the printer stops his labour, and the steeling is renewed. This process of steeling a plate is now very generally applied to engraved work on copper, and its effect is practically to abolish the distinction which once existed between proofs and prints. The value of a proof in former times consisted in the fact that it gave an impression of the plate in its full strength, before it had become worn by successive printings; but now there is in reality no limit to the number of impressions which can be taken from the steel plate, nor is there, as is sometimes supposed, any loss of the most delicate workmanship by the process of steeling. Indeed, Mr. Rajon, the well-known etcher, told me once that, for his own part, he almost preferred an impression taken after the plate had been steeled. Mr. Dawson's invention, which I have been describing, cannot, of course, rank among the more economical modes of book illustration. Copper-plate printing must always be costly, and by its nature it is unfitted for incorporation in printed text, but for the more expensive and luxurious sorts of book illustration it offers remarkable advantages, and it is especially valuable as a mode of reproducting, with absolute fidelity, the earlier forms of art. A process similar in kind, and evidently based upon the same principles, has been perfected in Paris by Mons. Dujardin; and in the *Gazette des Beaux Arts*, for the present month, may be seen some very remarkable specimens of the work he produces. In certain cases, the process enables us to do away altogether with the intermediate services of the draughtsman. Furniture, armour, or objects of vertu, may be reproduced directly, and with absolute fidelity and refinement; indeed, the result is, in some respects, more subtle than can be shown even by the most minute and careful engraving. No handiwork could preserve, with equal success, the appearance and surface of an embossed shield, or of a carved cabinet.

But the processes hitherto described, although they serve to illustrate the successful advance of mechanical invention, have only an indirect bearing upon our subject. They suggest comparison, not with the wood-block, but with the various modes of engraving on copper and steel; and although the initial outlay needed to produce one of these plates is infinitely below what would be demanded by a skilled artist, who had to etch or grave the design upon the plate, the means of multiplying impressions still effectually hinders the general application of such processes to the purposes of book illustration. All pictures taken from a copper-plate press must rank as what the French style *planches à part*. They can be inserted in the pages of a printed volume, and may powerfully add to the attractiveness, but they cannot be printed with the same facility or by the same means as are employed for producing impressions from moveable type. If, therefore, the genius of modern scientific discovery had gone no further, its influence upon the practice of book illustrations would not have been considerable. These processes, indeed, are highly valuable in the enlarged opportunities they offer for the reproduction of works of art. M. Goupil's invention, as you aware, has in a measure superseded engraving as a mode of multiplying copies of a picture in oil or water colour. The photograph is taken direct from the original painting, and transferred to the copper without the intermediate aid of any skilled handicraft, and however much opinions may differ as to the beauty of the results so obtained, it is impossible to deny that they carry an astonishing effect of illusion and resemblance. For it is to be observed that the impressions from Messrs. Goupil's plates do not merely compete with the older processes of engraving, but, in some respects, may be said to supersede them. Engraving on copper or steel, even in the hands of the most skilful exponents, does not aim at any minute imitation of the painter's handling. It has always been regarded rather as a translation than a reproduction, and its exercise has been determined by special laws and traditions, which may be said to constitute a recognised convention of style. In the first place, it is to be noted that, save in the case of mezzotint, all engraving is executed by means of line, and this fact serves, in itself, to distinguish the reproduction from the original, and to make the spectator sensible that the artist's invention has been translated into another language. And even in the finest examples of mezzotint, which so successfully preserve for us the masterpieces of Reynolds and Gainsborough, there is no attempt to suggest the actual appearances of the picture. The necessities of translation are still frankly and clearly acknowledged, and although the subtle modulation of tone comes nearer to the effect of painting than anything that can be produced in line, the result nevertheless ranks as the product of a separate art, which leaves room for the assertion of the engraver's individual style. But with these mechanical processes, based upon photography, this is no longer the case. It is the picture itself that is transferred to the plate, shorn only of the grace and attraction of colour. Something is necessarily lost by the way, for colour still offers certain hindrances to the photographer which modern science has not yet entirely removed. But, on the other hand, the mechanical process is able to afford a degree of realism in regard to the details of execution such as no engraver would have thought of attempting. In the most successful of these plates the actual impasto of the paint is successfully reproduced. The varying relief upon the canvas, which results from a vigorous handling, tells as a relief upon the carbon print, and is transferred again to the metal from which the printed impression is finally taken. Every touch of the brush is faithfully preserved, even where it is not exaggerated, and where colour is added, the effect of illusion is sometimes positively startling. This use of colour is, of course, only applicable to reproduction of water-colour drawings, and is, in fact, only a revival of a mode of copper-plate printing that was practised in England a century ago. It is impossible to get from a metal plate either the solidity or the gradation of a finished painting in oil, but on the other hand, transparent tones of colour may be so distributed over the surface of the metal as to give the effect of a washed drawing in water-colour. You have, no doubt, seen in the printsellers' shops some marvellous imitations, by Messrs. Goupil, of water-colour drawings by artists of the Continental schools. The more elaborate methods employed by our own water-colour artists would not, so readily, lend themselves to the process; but where the technical means are simple, and where the tints are laid on in a broad style, the resemblance is striking and remarkable. As we are treating of colour printing, I may be allowed to point out that the means here employed are essentially different from those which are used for wood blocks. The preparation of a copperplate, from which a coloured impresslon is required, is in itself an artistic process. The printer paints upon the metal as though he were painting upon paper. Each separate space must be supplied with its appropriate tint, which again must be cleaned in such a way as to yield varying strength of tone; and when this has been done, the impression is taken at once, and by a single printing. Coloured woodblocks are produced according to a totally different system. Each different colour requires a separate printing and a separate block, just as in coloured lithography there is to each colour a separate stone. Coloured block printing, which finds its widest employment in the production of wall papers, has lately been carried to a very high degree of perfection in the children's books issued by artists like Mr Caldecott and Mr. Crane. If you examine these pictures, you will find that great care is taken to give refinement and delicacy of tone by a finely-cut tint under the surface of the colour. Just as stained wood is always superior in effect to any imitation by means of solid pigments, from the fact that the natural grain showing through the colour gives variety and delicacy to the surface, so, in the same way, this mechanical graining of the wood-block tells in a manner equally agreeable and effective To my thinking, the best of these coloured wood-blocks far surpass in artistic merit even the most elaborate and expensive efforts of chromo-lithography. It seems almost impossible to get from the stone the same purity and freshness of tint that may be secured on wood, and although the resources of the latter are strictly limited, its finer quality tells strongly in its favour. The defects of chromo-lithography, for the purposes of illustration, were very strikingly shown in an expensive work on Japanese art lately published by Messrs. Audsley and Bowes. It would be impossible to have an example of a more lavish and luxurious style of execution, and yet it must be admitted, I think, that the result conveyed a very indifferent impression of the objects chosen for reproduction. The Japanese artist, whether he works on paper or porcelain, in lacquer or in metal, is, above all things, distinguished by the simplicity and freshness of his colouring. He does not aim at elaborate realism or gradation in tint, or at complex effects of tone, but he seeks rather to gain his effects by right choice and skilful combination of pure tints. Everything in his case depends upon quality of colour, and it is just this pure quality which lithography so often fails to render. Its helplessness in this respect is shown no less clearly in the careful reproductions of the frescoes and pictures of the early masters issued by the Arundel Society. No one can fail to recognise and to acknowledge the conscientious labour bestowed upon these works; but at the same time it must be frankly admitted that the simplest copy in water-colour gives a truer im-impression of the original than can be gained even from the most successful of these essays in chromo-lithography.

Simple lithography, which only aims at impressions in black and white, is a less costly and far more satisfactory process. Previous to the invention of the different modes of photographic engraving, it offered the only means of reproducing an original drawing in absolute *facsimile*. Wood and metal both alike demanded the aid of the engraver to carry out and interpret the artist's design, but in lithography the artist could work directly upon the stone, or, if the drawing were on paper, it would be mechanically transferred to the stone. Lithography has not, in England, attracted any very serious artistic notice, nor has it been carried to any great degree of perfection. But in France its peculiar resources have been more highly esteemed, and many admirable lithographs have been produced, in which the draughtsman has adapted himself with tact and skill to the special conditions of the art. It may be worth while to say a word about the actual process of lithography, for the reason that it has an important bearing upon the different modes of photographic engraving which I am about to describe. The principle of lithography, it should be understood, is not purely mechanical. The impressions from the stone are taken in a press, but the ink is not delivered from a raised surface, as in the case of a wood-block, or from an incised line, as in the case of a metal plate. The picture is neither cut into the surface of the stone nor elevated in relief upon it, and, therefore, the means by which successive impressions are obtained may be said to be chemical rather than mechanical. The stone used in lithography is a sort of calcareous slate which is found in Bavaria. It is carefully prepared, either by graining or polishing, according to the character of the drawing that is to be reproduced. In either case, the ink or chalk employed by the draughtsman is of special composition, being, in fact, a mixture of grease and soap coloured with lamp-black. When the drawing has been made in this material, a weak solution of nitrous acid is poured over it, in order to render the ink or chalk insoluble in water. The necessity for this precaution arises from the fact that the stone has to be wetted with a sponge before each impression is taken. The water so applied to the surface is repelled by those parts which are covered with the greasy chalk, and is absorbed into the untouched portions of the stone; and conversely, when the roller, covered with printing ink, is now passed over the surface, the ink, which is combined with oil, unites readily with the greasy surface of the drawing, and is repelled by the wet surface of the stone where the water has been imbibed. The stone is now ready for printing, and the same process is repeated for every impression. Lithographic printing, therefore, depends, it will be observed, upon the antipathy of oil and water. The greasy nature of the material employed by the draughtsman unites with the grease of the ink, and enables the printer to multiply impressions without loss of any of the qualities of his original design. But lithographs are not always drawn directly on the stone. They can be transferred from paper specially prepared for the purpose; and it is the power of transferring the original design which enables lithography to make use of the resources of the photographer.

I have described the process of lithography, because it will enable you the better to understand the means by which a photo-engraving in relief is usually obtained. These relief blocks have now been in use for some years, but it is only recently that they have shown signs of sufficient excellence to render them worthy rivals of wood engraving. Their great merit, where they are successful, is that they give us the absolute autograph of the artist. The photographer here takes the place of the wood engraver, and allows the original draughtsman to speak for himself. Or, at least, it should rather be said that this is so in principle; in practice it must be acknowledged that photography cannot always claim the absolute veracity which is sometimes attributed to it. It inevitably coarsens, to some extent, even the simple lines of a pen-and-ink drawing, and it takes no account of varying depth or strength of colour. The photographic engraver can distinguish between a broad line and a thin line, though he is apt to exaggerate both; but he is wholly powerless to effect any distinction between a dark line and a light line. In this respect it must be admitted that all these processes are still inferior in effect to the wood-block, in the treatment of which the engraver has at his command numerous devices for giving varieties and refinements of tone. But it must be allowed, nevertheless, that in dispensing with the services of the engraver there is an important gain of another kind. It is something to have the actual touch of the original artist, even though the interpretation is somewhat rough and clumsy; and when the artist has learned to adapt his work to the conditions of the process, results will be obtained such as could not be secured even by the most painstaking and conscientious engraver. For it is to be observed that the process itself is capable of a vast amount of improvement, and the results now obtained already compare very favourably with the earlier and cruder experiments. Apart from the lack of variety in tone, which was a patent defect of those earlier essays, there was another and more serious disadvantage arising from a certain rottenness and insecurity in the lines themselves. This arose partly from the employment of paper unfitted for the purpose, and partly from an uneven biting of the metal. Photography not only exaggerates the actual work of the draughtsman, but it caricatures the surface of the paper, and if this surface be rough and uneven, the lines, when they are transferred to the metal, lose sharpness and consistency. Mr. Dawson, whose ingenious method of photo-mezzotint engraving I have already described, sought to overcome these defects by a process which he has described as typographic etching. Here the drawing was actually made upon a prepared plate in a manner partly corresponding to real etching, and the black in relief was afterwards obtained by a cast. But this process had not, after all, the advantage of rendering in *facsimile* an original drawing; and I now, therefore, pass to the consideration of the various modes now adopted for obtaining relief blocks through the intervention of photography.

As the conductor of two artistic magazines, one of which is produced in France, I have had the opportunity of scrutinising very closely the results produced by the different professors of this kind of engraving both in England and abroad. The principal firms in France at the present time are the Messrs. Gillot, Messrs. Yves and Barret, and M. Petit, and very favourable examples of their skill are to be seen in the pages of *L'Art* and the *Gazette des Beaux Arts*. The point in which they seem to me to surpass most of their rivals in this country, lies in the ability to interpret drawings in charcoal and chalk, as well as drawings in pen and ink. It certainly appears, at first sight, a very remarkable gain to the resources of illustration, to be able to print from a relief-block in such a way as to imitate the crumbling touch of a chalk drawing, and this has, in some instances, been very successfully accomplished. Very much, of course, depends upon the skill of the printer in handling these photographic blocks, as they undoubtedly demand more adroit handling than is bestowed upon the ordinary wood-block. The art of printing illustrated works is unquestionably more widely understood in France than with ourselves, and to this cause we must attribute some part of the superiority which the French processes would seem to possess. In London there are, by comparison, only a limited number of printing firms which devote special attention to this class of work, and although the results obtained in these isolated cases are highly satisfactory, the production is, as a general rule, far more costly. But even the best of these French processes, aided and supported as they are by the greater skill and resource of the French printer, are scarcely superior to a process to which I shall specially draw your attention to-night. This process is the invention of a German gentleman, Mr. Henschell, who is a resident in this country, and who has kindly afforded me every facility for explaining to you the peculiar methods of his work. There are many others of the same kind, and based mainly upon the same principles; but as there are considerable differences in detail, I have thought it best to-night to confine myself to the description of a single example. The faults common to nearly all the processes to which I have referred are, as I have said, of two kinds. In the first place, the line which was firm and steady in the original drawing is apt to exhibit a certain rottenness when it reappears upon the block, and further, the block commonly fails to distinguish successfully between lines of varying strength. It may even be said that where the original drawing has passages of delicate execution, even though expressed in line, these delicate parts disappear altogether, and the printed impression from the block is, by comparison, crude and coarse in effect. In order to understand why this should be so, it will be necessary to explain the different stages in the production of one of these blocks. The first requisite, common to every process, consists in a good clear negative from the drawing which has to be reproduced; but the real difficulty begins when it is sought to transfer this negative on to the metal. Now, this has usually been accomplished by means of transfer paper, such as has long been used by lithographers. This transfer paper is so treated as to be sensitive to the action of light, and an ordinary photographic print is then taken upon it, which is afterwards treated with lithographic printing ink and transferred to the smooth surface of the zinc plate. But the conditions which make it necessary to employ this transfer paper are unfavourable to the photographer. In order to secure detail, the light must act through the transfer substance, and fix the image to the paper itself, but unfortunately the exposure required to effect this result intensifies the darker parts of the picture to an exaggerated degree. The engraver has, therefore, to choose between two evils. Either the black parts of the picture will be too strong, or the lighter and more delicate portions will be lost altogether; for unless the light has penetrated the transfer substance and fixed the image to the paper, these delicate features will inevitably be washed away with the transfer material and never reach the metal at all. And this, in fact, is what unsually happens. If an ordinary process block is compared with an ordinary drawing of any subtlety or refinement, it will be found not merely that the lines are rotten, but that many finer lines which gave beauty to the drawing have no existence in the block at all. And there is yet a further disadvantage incidental to the usual mode of procedure. The transfer to the metal can only be effected by pressure, and the pressure has the inevitable result of destroying the delicate work, and rendering the lines indistinguishable. When the image, with whatever loss it has suffered by the way, has been transferred to the metal plate, it is treated very much in the manner already described in connection with lithography. The surface is covered with gum, so as to resist and repel the printer's ink, which is now applied by the lithographic roller, and which only adheres to those parts where the transfer ink has been impressed. The plate so inked and prepared is now ready for the acid bath. It might, if we chose, be treated as a lithograph, and impressions might be taken from it just as they are taken from the surface of the stone. But our object now is to produce a block in relief which shall be adapted for printing in an ordinary press with moveable type, and with this purpose in view, the next thing to be done is to bite away all those portions of the plate which are not occupied by the lines of the drawing. The zinc plate is therefore placed in the acid bath in the same manner as an etching, only that here the process is reversed, and instead of eating into the lines of the drawing, the acid eats away all those portions which surround these lines, which are themselves protected from chemical action by the ink which covers them. As the biting gets deeper, care is needed in order to protect the sides as well as the upper surface of these lines, otherwise they would be undermined, and would then fall away; and for this purpose the ink has to be applied again and again during successive stages of the biting.

The method I have been describing is the ordinary method of producing a process block. It may differ in detail, or according to the varying systems of different inventors, but the principle is the same in all, and it is subject in all to the peculiar disadvantages I have pointed out. By way of removing some of these disadvantages, Mr. Henschell, and others who have worked in the same direction, have found a means of doing away altogether with the ordinary transfer process, and of therefore avoiding the grave defects which it involves. Instead of taking a print from the negative, upon transfer paper, he takes it upon a composition of his own preparation, which retains all the most delicate features of the photograph. The print so obtained, which resembles a carbon print, and has the same quality of relief, is then laid, with its face downwards, upon the metal plate, and is then developed; and when this development is complete, the paper to which the composition is attached is removed, and the composition itself is washed away, save only in those places where the action of the light has taken place, and which remain attached to the plate. No pressure is needed in this mode of registering the picture upon the plate, and, therefore, none of the finer work is filled up or destroyed. And, again, it may be remarked, that when he has once got the picture impressed upon the plate, it is at once in a condition to be treated by the acid. The composition itself, in the earlier stages of the biting, suffices to protect the drawing from the action of the acid. Though it is not greasy, like the printer's ink, it has chemical properties which serve equally for the purpose, and the strong printer's ink is only applied at a later stage.

In the presence of improvements like these, it would be rash to declare that photographic processes have even yet reached the point of full development. Every day brings some new element of refinement, and if the progress in the future is to be measured by that which has been achieved in the past, it is more than probable that the craft of the engraver will be almost entirely superseded. Nor even if this should be the ultimate result of the alliance between science and art, would there be any great cause for regret. As to wood engraving, it has been made sufficiently clear, by our brief examination of its history, that it has never ranked higher than art of reproduction. With one single exception, it has never been used as a means of independent expression, and as the efforts of all the best engravers have been directed to the faithful reproduction of an original drawing, art will suffer no real loss should this same result be achieved by purely mechanical means. But it will then more than ever become the duty of the original artist to fit his work to its destination, and to consider, when he is engaged upon the illustration of a printed volume, what is the style of execution that will give the happiest expression to his ideas. With no intermediate craft between himself and the printer, he will have no excuse for employing inappropriate material, or for cumbering the printed page with work that displays an excess of elaboration.

Miscellaneous.

FORESTRY IN JAMAICA.

In the last report of the Director of the Public Gardens and Plantations in Jamaica (Mr. D. Morris), special attention is drawn to the condition of forest conservation. Mr. Morris writes:—

"With regard to the reciprocal influences which exist between the existence of forests and climate, I do not wish to speak too decidedly. It has, however, been observed that certain consequences follow the clearing off of forests, which can scarcely be otherwise regarded than as a direct effect, such as the diminution of rivers, and the drying up of streams and springs. Other effects, scarcely less certain, are seen in the occurrence of destructive floods, of unseasonable and prolonged drought, with other vicissitudes of climate, which it is alleged did not occur when the country was covered by forests. In our own island, we have painful evidence that where land has been carelessly cleared of timber, small perennial streams, which formerly had their beds kept up nearly level with the surface by the obstruction of roots and fallen timber, have now so deeply excavated their channels, as to cause serious landslips, or 'breakaways.' Many properties have thereby become seriously depreciated in value, and not only so, but as a result of the excessive drainage thus supplied, they have become so dry and arid as to be almost unsuitable for any cultivation whatever. I am aware that differences of opinon have been expressed among scientific men as to the extent of the influences that forests exert upon climate, and it is quite probable that the advocates of extreme theories may have erred on both sides. The experiences gained at St. Helena, Ascension, Mauritius, South Africa, and Ceylon cannot, however, be ignored; and the almost unanimous verdict which has been given by these places in favour of forest conservation and *reboisement*, cannot but commend itself to the serious attention of all interested in the welfare of our colonial possessions. In Jamaica, there can be no doubt whatever that it is most desirable to preserve existing forests as much as possible, both for the sake of the timber they contain, and also for their influences in retarding the too rapid flow of water; in preserving springs, and in acting as screens, wind-breaks, and shelter-belts for existing and future properties in cultivation under coffee, cinchona, &c."

Mr. Morris then refers to what the Government has already done to preserve the existing forests, and adds:—"In offering suggestions upon the manner in which forest conservation and *reboisement* may be furthered, the first important step required to be taken is to survey and carefully mark out all Crown lands, and especially those which are to be reserved in aboriginal forest. Such forest reserves should be carefully mapped out on a scale of 1,000 feet to the inch, and their boundaries indicated by permanent marks. If a separate department (Crown Lands Department) in the general administration of the island cannot be organised, it would be advisable to place the management of forest reserves, and crown lands requiring skilled supervision, either under officers connected with the Surveyor-General's Department, or the Department of Public Gardens and Plantations. Such officers, with a small staff of forest rangers, could very well conserve and maintain the existing forests, and take systematic steps to replant denuded areas."

Mr. Morris points out that by this means the extra cost would be very small. He then refers to the Report on the Forests of Mauritius, and a Report on the Forests of Ceylon, in course of preparation, and he proposes that a similar report for Jamaica should be undertaken. He concludes :—"In the meantime, however, attention might be specially directed, so as to secure on Government lands—

"1. The prevention of wasteful and indiscriminate cutting down of timber, and an extension of the conditions already published in connection with cinchona cultivation, as regards cutting down timber on ridges, in the neighbourhood of springs and watercourses, and along banks of rivers.

"2. Prevention of forest fires. These fires are very frequent in remote back lands, and are chiefly caused by the careless use of fires on negro provision grounds. On one property under my own observation, there were nearly fifty acres burnt down, merely to supply a negro cultivator with half an acre of land to plant cocos and yams. I estimate that more than 2,000 acres of land, more or less in forest, are burnt every year in the island, beyond what is absolutely necessary for purposes of cultivation.

"3. A restriction and consequent limitation of the system of provision ground letting, is urgently called for in the interest of both Government lands and those in private hands. The evils of the system are, I believe, quite capable of amelioration, and I am doing much in this way with the Government lands under my charge. A system of rotation of crops has already lessened the evil by at least one-half; and I hope to draw further attention to this subject in my Departmental Reports.

"With regard to the reforesting of areas already denuded, my recommendations are :—

"1. Government lands in ruinate, or only slightly clothed with vegetation, might be let on lease, free, or at a nominal sum, on condition that some portion is planted up with trees every year.

"2. Large nurseries for valuable trees might be established by Government, from whence owners of properties, and lessees, mentioned in the last paragraph, might get plants free of charge.

"3. Information of a practical character, respecting forest conservation, and the methods best adapted for establishing plantations, should be diffused throughout the island, together with a yearly report as to the state of the forests and timber supply, and the progress made in reforesting."

PETROLEUM DEPOSITS IN THE ARGENTINE REPUBLIC.

In the upper provinces of the Argentine Republic there have lately been discovered petroleum deposits, apparently of great richness and extent, and it is believed that the eastern slopes of the *sierras* of the Andes are underlaid in many places with this mineral oil. One of the deposits is situated in the province of Jujuy. It consists of a lake of about eighty-eight acres in extent, and of unknown depth, and is covered with asphalt. The liquid itself is somewhat thick, of a black colour, and has no disagreeable odour. Consul Baker, of Buenos Aires, states that having obtained an analysis of the liquid, he is of opinion that the oil compares very favourably with those of Pennsylvania, Canada, Rangoon, &c. The Jujuy kerosene has the additional advantage of being without disagreable odour, and will not ignite under 55° Centigrade. It is colourless, and is pronounced equal to the best that comes from the United States. Deposits of petroleum have also been recently discovered in the province of Mendoza; one of these is only a few miles south-west of the old site of the City of Mendoza, destroyed by an earthquake in 1861, and a concession has already been granted by the Government for working these deposits. According to analysis made in England, most excellent results were obtained; the yield is stated to be nearly 40 per cent. of kerosene, and what adds to the importance of the deposit, is the fact that the oil flows to the surface, and thus offers a constant supply of the crude petroleum. A similar deposit has been discovered about twelve leagues north of the present city of Mendoza. But a still more important deposit than either of these is found in the same province about eighty leagues south of Mendoza. Similar to that of Jujuy, it is an extended lake of oil, the covering also being asphalt, extending over a large surface, and offering the petroleum almost without expense in quantities which, according to reports, are almost inexhaustibe. By analysis it has been found to yield 40 per cent. of pure oil. So great, says Consul Baker, is the appreciation of this great source of wealth to the country, that a scheme has already been proposed, and negotiations commenced, for a railway from Buenos Aires, running through this oil region, to Chili.

Notes on Books.

A TREATISE ON THE TRANSIT INSTRUMENT, AS APPLIED TO THE DETERMINATION OF TIME, FOR THE USE OF COUNTRY GENTLEMEN. By Latimer Clark. London (6, Westminster-chambers), 1882.

The author desires to see the transit instrument brought into more general use for purposes of utility and amusement, but more especially as a means of obtaining true time for clocks and watches. With this purpose in view, he has written the present volume in a familiar style, so that it may be understood by those who desire to use the transit instrument, without necessarily caring to study the principles of its construction. The instrument itself is described, and instructions given for taking transits of the sun, and of the stars; and for the correction of longitude and latitude. In the second part, the various points connected with mean and sidereal time, and the determination of the value of transit corrections, are discussed. The author remarks on the circumstance that astronomers in all ages, and in all countries, have continued to designate sidereal time by the same names as ordinary time. He suggests that the sidereal second should be called a *kron* (from its being used as the unit measure of time); and the sidereal hour a sider; the minutes scarcely needing alteration. And he adds that this change would be a great convenience to sailors and practical men, who are confused by the present system. A series of transit tables, for 1882, computed from the *Nautical Almanac*, is added. The high cost of a transit instrument having been one of the chief obstacles to its introduction, Mr. Clark has induced the manufacturing opticians to produce a useful instrument at a greatly reduced price.

The Action of Lightning, and the Means of Defending Life and Property from its Effects. By Arthur Parnell. London: Crosby Lockwood and Co. 1882.

This little book is divided into three parts. The first part contains facts and opinions on lightning and lightning engineering, with a full table of incidents of the action of lightning, arranged under the following headings:—Time, place, object, particulars, lightning-rods present, metals present, results, and authority. The first entry is dated 12 Sept., 1747, and refers to the case of a woman who was killed near Toulouse, when the sky was clear, with the exception of one small round cloud. The second part is devoted to the theory of the action of lightning, and contains a table of the influence of various substances, and some observations on the history of lightning-rods, and the opposition raised to their use. In the third part are set forth the practical measures advocated by the author for the defence of life and property from the effects of lightning.

General Notes.

Meat Trade.—The frozen meat trade, according to the correspondent of the *Times* in Victoria, seems to be gathering strength with each successive shipment. The *Chimborazo*, which has lately arrived in London, took 1,900 carcasses of sheep of large size and prime quality. They were frozen and packed with great care at the Maryburnong Company's works. At Sydney the same vessel shipped 2,700 carcasses of mutton, of equal quality, but smaller than those shipped here. The retail butchers in Melbourne must be making enormous profits, for, while this frozen meat company are exporting at a profit on sales in London, at 6½d. per lb., after paying freight and expenses, we are paying 8d. per lb. for prime joints in Melbourne.

Reducing the Precious Metals by Electrolysis.—According to a note in *Engineering*, MM. Blas and Miest state that they have discovered a process for economically extracting the precious metals from their ores by means of electrolysis. It consists in substituting for the anode of the electrolytic bath plates of compressed sulphur ores; the salt of the bath having the same metallic base as the metal of the ore. An electric current sent through such a bath decomposes the anode, liberating the sulphur, which falls to the bottom of the bath, whilst the metal is deposited on the cathode. This metal is derived in the first place from the solution in the bath, which, however, renews its strength from the metal contained in the ore of the anode, as long as that remains. In operating on sulphides and sulphurets containing several metals, it is necessary, afterwards, to separate these metals from each other, but this is also done by the aid of a second or a third electrolytic bath.

Elementary Instruction in Hungary.—The tenth report of the Hungarian Ministry of Public Instruction for the scholastic year, 1879-80, has recently been published, and contains some interesting information respecting the educational progress made in Hungary during the last ten years. Accordcording to the *Journal de la Société de Statistique* of Paris, which gives a *résumé* of the report, the number of communes in 1869 amounted to 12,564, in 10,187 of which elementary schools were to be found. In 1880, out of 12,814 communes, the number having these schools amounted to 10,664, showing an increase of 477. The number of schools themselves amounted, in 1869, to 13,798; in 1880 it rose to 15,824, and as regards the number of persons engaged in teaching the proportionate increase was considerably greater, as in 1880 there were 21,661, against 17,792 in 1869; and in the same period the number of pupils increased by 467,577. The children, to the number of 1,619,692, frequenting these schools in 1879-80, were classed according to their religious belief, as follows:—Roman Catholics, 849,544; Greek Church, 303,658; Calvinists, 236,435; Lutherans, 154,258; Unitarians, 6,705; and Jews, 68,392; and, as regards nationality:—Magyars, 787,187; Germans, 267,282; Roumanians, 204,950; Slavs, 253,642; Serbs, 36,850; Croatians, 25,839; Rusniaks, 43,242. In the majority of cases, the elementary schools are supported by the parishes or the different religious communities. Out of 15,824 schools, 13,722 are so supported, and in addition to these there are 1,669 communal, 266 national, and 167 private schools. Those establishments in which instruction is given in one language, amount to 13,387, and are as follows:—In the Magyar language, 7,342; Roumanian, 2,756; Slav, 1,716; German, 367; Rusniak, 393; Servian, 245; Croatian, 68. There are 2,247 in which instruction is given in Magyar and one other language, and 102 in which it is given in three languages.

Journal of the Society of Arts.

No. 1,563. Vol. XXX.

FRIDAY, NOVEMBER 3, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

LABELS FOR PLANTS.

In addition to the prize offered by Mr. G. F. Wilson, F.R.S., particulars of which have already been announced, a prize of five guineas has been placed at the disposal of the Council of the Society by Mr. E. G. Loder, for the best permanent border label suitable for private gardens, the cost of which should not exceed £4 per thousand.

Both awards will be made on the recommendation of the Committee appointed for the purpose by the Council.

Further particulars will be issued shortly.

UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement :—

Young Men's Christian Association, Manchester.

ARRANGEMENTS FOR THE SESSION.

The first meeting of the One Hundred and Twenth-ninth Session of the Society will be held on Wednesday, the 15th November, when the Opening Address will be delivered by CHARLES WILLIAM SIEMENS, D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be five ordinary meetings, in addition to the opening meeting.

Candidates proposed for election as members are privileged to attend the opening meeting.

ORDINARY MEETINGS.

The following papers will be read on the Wednesday evenings before Christmas :—

"Refrigeration by Evaporation of Water in Vacuo." By J. HOPKINSON, D.Sc., F.R.S.

"The Utilisation of Waste. A Retrospect of Recent Progress." By P. L. SIMMONDS.

"The Artificial Drying of Crops." By WILLIAM A. GIBBS.

"Electrical Exhibitions." By W. H. PREECE, F.R.S.

"The Sanitary Inspection of Houses." By W. K. BURTON.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 30; February 27; March 20; April 3; May 1, 29.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock :—

January 25; February 22; March 8; April 12, 26; May 24.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock :—

February 16; March 2; April 6, 20; May 4, 25.

CANTOR LECTURES.

The First Course will be on "Dynamo-Electric Machinery." By Prof. SILVANUS P. THOMPSON, D.Sc.

December 4, 11, 18.

The Second Course will be on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

January 29; February 5, 12, 19, 26; March 5.

The Third Course will be on "The Decorative Treatment of Metal in Architecture." By GEORGE H. BIRCH.

April 2, 9, 16.

The Fourth Course will be on "The Transmission of Energy." By OSBORNE REYNOLDS, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

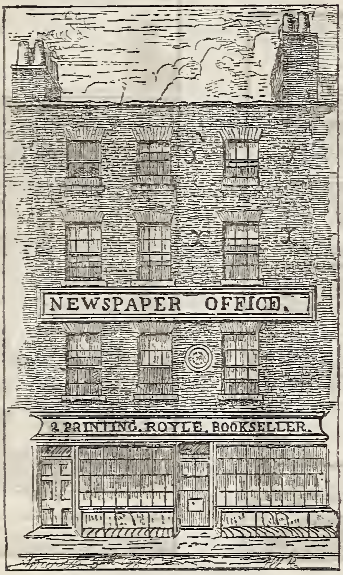
April 23, 30; May 7.

The Fifth Course will be on "Secondary

Batteries." By Prof. OLIVER J. LODGE, M.A., D. Sc.
May 21, 28.

JUVENILE LECTURES.

The two Juvenile Lectures will be by PROF. HENRY NOTTIDGE MOSELEY, M.A., F.R.S., on "The Inhabitants of the Ocean." The dates for these are Wednesday evenings, the 3rd and 10th January. Special tickets will be issued for these lectures, due announcement of which will be made.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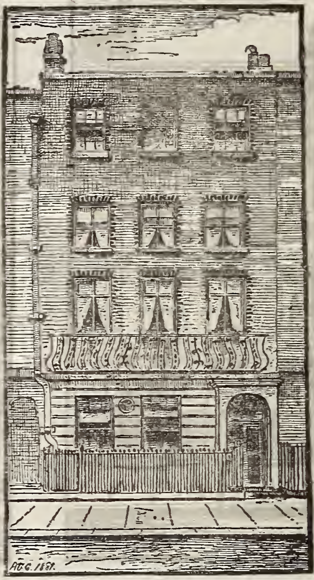
& PRINTING. ROYLE. BOOKSELLER.

NO. 2, BLANDFORD-STREET, WHERE FARADAY WAS APPRENTICED.



7, CRAVEN-STREET, WHERE FRANKLIN LODGED IN 1770.

MEMORIAL TABLETS.

In the last volume of the *Journal* (October 7th, 1881, p. 823), an account was given of the Memorial Tablets which have been set up by the Society of Arts on certain houses in London, once inhabited by istinguished persons, and this notice was illustrated by engravings of four of the houses (Canning's, Flaxman's, Johnson's, and Newton's) from blocks kindly lent by Messrs. Dawson, of the Typographic Etching Company.

It is proposed to give representations in the *Journal* of all the houses which have been distinguished by tablets, and Messrs. Dawson have been so good as to lend the blocks used in the present notice. These represent houses connected with the philosophers Faraday and Franklin; the composer Handel; the Emperor Peter the Great; and the statesman, Sir Robert Walpole.

Michael Faraday, 2, Blandford-street, Portman-square.

Benjamin Franklin, 7, Craven-street, Strand.

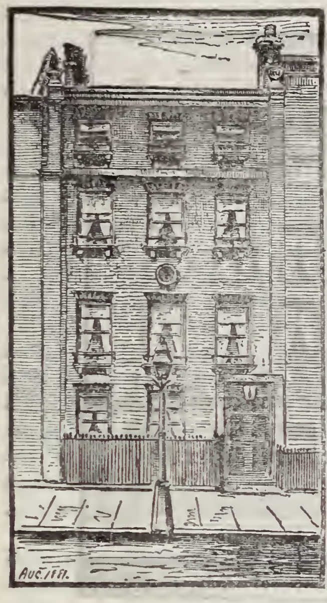
George Frederick Handel, 25, Brook-street, Grosvenor-square.

Peter the Great, 15, Buckingham-street, Strand.

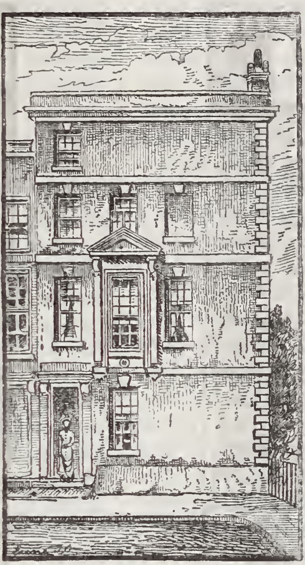
Sir Robert Walpole, 5, Arlington-street, Piccadilly.

Faraday lived the greater part of his life at the Royal Institution in Albermarle-street; but the house No. 2, Blandford-street, chosen for the memorial tablet, is that in which he served his apprenticeship. The home of Faraday was in Jacob's-well-mews, from the time he was five years old, until he went to Blandford-street. The mews was only a few yards from the shop, whose front at that time was but slightly different from what it is at present. In 1804, Faraday entered the service of Mr. George Riebau, a bookseller and stationer, as errand boy, on trial for a year. It was his duty to carry round the papers that were lent out by his master, and to call for them again when they had been read. In the following year, he was bound apprentice to Mr. Riebau, and, in consideration of his faithful service, no premium was required from his father. He now worked as a bookbinder, and in his spare time he studied science, his attention being turned in that direction by the article "Electricity" in an Encyclopædia he was employed to bind. In October, 1812, Faraday went as a journeyman bookbinder to a Mr. De la Roche, a French emigrant in London; and early in March, 1813, he became an assistant in the laboratory at the Royal Institution.

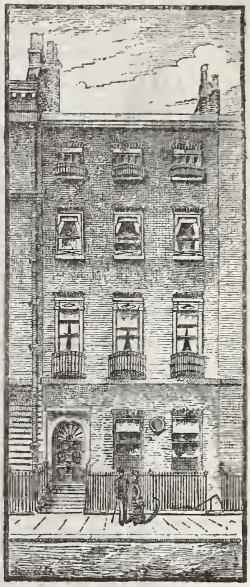
Franklin lived in several parts of London during the periods of his frequent visits to England. When he first came as a poor man, he worked at Palmer's printing-office, and lived in Little Britain; and he afterwards lodged in Duke-street, Lincoln's-inn-fields, when engaged at Watts's printing-office. In his more prosperous days, he lived in one or two of the streets out of the Strand. His favourite residence was No. 7, Craven-street, where he boarded with the family of Mrs. Stevenson. His association with this house is commemorated in one of his numerous fugitive pieces. In 1770, he wrote a paper called the *Craven-street Gazette*, containing a humorous journal, supposed to have been kept during the absence of Mrs. Stevenson from home. This is published by Jared Sparks, in the second volume of his edition of Franklin's works.



HANDEL'S HOUSE, BROOKE-STREET.



NO. 15, BUCKINGHAM-STREET, WHERE PETER THE GREAT LIVED IN 1697.



SIR ROBERT WALPOLE'S HOUSE, ARLINGTON-ST.

Handel first visited England in 1710, and soon afterwards settled in this country. He was well received here, and for a time, lived with his patron, the Earl of Burlington, at Burlington House, Piccadilly, and the magnificent Duke of Chandos, at Cannons, near Edgware, Middlesex. The exact date when he moved to Brook-street is not known; but in the year, 1725, the parish of St. George's, Hanover-square, was separated from that of St. Martin's-in-the-fields and in the first parish book the name of George Frederick Handel, Esq., is found, as rated to the poor for this house at £35 per annum. Handel continued to be rated up to 1759, the year in which he died. His servant, John Duburk, then took the house, and purchased the furniture which was contained in it. Mr. Victor Schœlcher, the biographer of Handel, suggests that Duburk converted the house in Brook-street into a lodging-house, in the expectation that the memory of his master would attract visitors. The house is now No. 25; it was formerly numbered 57. Handel was for years a constant attendant at the neighbouring church of St. George's, Hanover-square.

In January, 1697, Peter the Great came to England, and the house, No. 15, Buckingham-street, overlooking the river, was provided for him. During his visit, he dressed in the English fashion, sometimes as a gentleman, sometimes as a sailor; but the mob soon found out his quality, and as he went abroad with few attendants, his movements were considerably interfered with, and he expressed his desire to be not only out of the town, but also below bridge amidst the shipping. Arrangements were therefore made with John Evelyn, and he took up his residence in Evelyn's home at Deptford. This suited him exactly, for he was able at once to get into the dockyard by passing through a back door in the garden. It is worthy of note that when Peter was staying at the last house on the east side of Buckingham-street, Samuel Pepys was living in the opposite house, No. 14, at the bottom of the street on the west side. The Russian Czar may, therefore, be said to be in some way connected with the two celebrated diarists. It is necessary to bear in mind that in the time of

Pepys and Peter the Great, this district was named York-buildings, from having been built on the site of old York House, and they are both described as living, not in Buckingham-street, but in York-buildings. The street bearing that name at present was formerly called George-street.

Sir Robert Walpole lived in one of the large houses in Arlington-street, on the west side, in 1716, and in the following year, Horace Walpole was born there. Sir Robert's great rival, William Pulteney, Earl of Bath, was his next door neighbour. The house was afterwards pulled down, and rebuilt by Kent, when the Right Hon. Henry Pelham moved into it. Other statesmen lived in the street, which well deserved to be styled, as Horace Walpole does style it, "the ministerial street." In 1742, Sir Robert Walpole resigned office, and was created Earl of Oxford. He then moved from Downing-street to a smaller house on the east side of Arlington-street, No. 5 (where the tablet is now placed). Horace Walpole lived here with his father, and in a letter dated November, 1st, he complains of a bad cold caught from going into an unaired house. Here Sir Robert died in 1745, leaving the remainder of the lease (which expired in 1781) to his son Horace, who moved to No. 11, Berkeley-square in 1779. Horace wanted his friend George Montague to come to live in the house next door but one to him, and in a letter, he says, nothing can be more dignified than the position, but he adds, "yet you and I, I doubt, shall always live on the wrong side of the way."

Besides the nine houses shown in this and a former number, there are eleven more which still remain to be illustrated, and arrangements are now being made for the erection of several additional tablets.

THE MANUFACTURE AND PREPARATION OF JAPANESE LACQUER

(Continued from p. 1054.)

Nakanuri-urushi (middle-painting varnish).—This is merely the crude lacquer. After having been exposed for some time to the sun to darken it, and to get rid of all water, it is used for undercoats for making first-class ware.

Nuritate-urushi (finishing lacquer).—This is a mixture of crude lacquer and a little turpentine with *Tō-midzu* (whetstone water), being the mixture obtained from whetstones on which blades have been sharpened. In it there is some 7 to 8 per cent. of iron, and after mixing, the whole is exposed to the sun, both for the purpose of getting rid of all the water, and to darken the colour. This is used for final coats of cheap lacquer, which is not polished afterwards.

Jō-hana-urushi.—This is a mixture of the above kind, with oil obtained from the Ye plant (*Perilla ocymoides*). This is used for still more common kind requiring no after polishing, and the lacquer does not present a hard surface.

Jō-Chiu, called in Kioto, *Chiu-hana; Jō-tame* called, in Kioto, *Ge-hana.*—These contain more and more oil, and are used for the commonest articles, such as for varnishing clogs, clothes baskets, &c. These three last kinds give a high polish, but the lacquer does not last.

Shu-urushi (*vermilion lacquer*).—This is the best crude or transparent varnish mixed with Ye oil (*Perilla ocymoides*), sometimes as much as 50 per cent. being added. It is then exposed to the sun, and water added, which is afterwards evaporated. This kind is only used for red (whence its name) and coloured lacquers; the colours being added at the time of application. It requires no after polishing.

(B.) FOR LACQUERING WITH GOLD.

Nashiji-urushi (pear basis lacquer), or *Suki-urushi (transparent lacquer).*—The first name is that best known in the trade, as indicating that it is required for using over gold, silver, or tin powdering. It consists of the finest crude lacquer obtained from old trees. As stated previously, the lacquer is allowed to stand till all dirt and foreign matter has sunk to the bottom, when the best is skimmed off, and after being exposed to the sun to evaporate the water in the usual manner, and carefully filtered, it is ready for use. Except when used for the highest class of gold powdering, a certain proportion of gamboge is mixed with the lacquer to give the dust a fine yellow colour.

N.B.—The above ten kinds are all brought by the lacquer workers, ready prepared from the manufacturers. Any further mixtures used by them are made as required, colours added, &c.

Seshime-urushi (*branch lacquer*), and *Rō-urushi* are used also in making gold lacquer.

Yoshino-urushi.—This is crude lacquer from the district of Yoshine in the province of Yamato. It dries quickly, and closely resembles transparent varnish. It is used when giving the final coats before polishing.

Yoshino-nobe-urushi (*Yoshino spreading lacquer*).—Same as above, with the addition of about one-third of camphor to render the lacquer thinner and more easy to spread.

Seshime-nobe-urushi (*spreading branch lacquer*).—This is merely branch lacquer with the same proportion of camphor as above; when cheap work is required, more camphor is used till the proportions are reversed. This renders the mixture very soft, and a small quantity can be spread over a large surface.

Shita-maki-urushi (*under coat lacquer*).—A mixture of branch lacquer and benigara (red oxide of iron), in equal parts by weight.

Ke-uchi-urushi (*inside line lacquer*).—This is the same as above, but it is allowed to stand for about six months after mixing before it is used. By this time it has got thicker, and the very finest lines can be drawn without fear of their running, and they moreover stand out better.

Shita-maki-nobe-urushi (*under coat spreading* *lacquer*).—Same composition as above, with the addition of a little camphor to make the lacquer thin. It thus goes much farther, and causes a great saving when lacquering with powdered gold leaf (*keshi fun*), for which it is best suited. As in the other mixtures, the more camphor is used, the thinner it renders the lacquer, and the less gold is required.

Taka-maki-urushi (*raised lacquer*). — To make this a certain quantity of *ro* or *nuritate* is taken and divided into three parts. To one part is added lampblack and camphor, in equal portions of bulk. These, after being well mixed are boiled together; then the other two portions are added, and the whole stirred together, and afterwards filtered through paper. It is boiled more or less according to the season. In summer, when lacquer dries quickly, it is boiled for a longer period, while in winter or during cold weather, when lacquer naturally takes longer to dry, the mixture is boiled for a shorter time. The reason why *Taka-maki* is thus purposely rendered soft, is explained by the fact that otherwise the upper surface would harden at once, while the under portion, *Taki-maka* (being applied thickly), being excluded from the upper air, would not be able to dry, and later, the top surface would crack and show fissures, whereas the introduction of camphors renders it soft and much slower to dry, and the whole has thus time to harden equally. Camphor being volatile, is gradually lost, and the composition becomes quite hard.

Ro-se-urushi (a mixture of black and branch lacquer).—This is used for the lacquer coating upon which gold, silver, or tin powder is scattered, except in such cases where the grain of the wood is to be shown, when Nashiji lacquer is used instead.

Kuma-urushi (shading lacquer).—A mixture of *Jōhana* lacquer and lamp black, used for final shading in the feathers of birds or animals, or for drawing hair, &c., on flat and raised gold lacquer.

It should be noticed that whenever lamp black is mentioned as a mixture, it is used for the superior kinds, wood or coal-soot being used for inferior articles.

From a perusal of a list of materials and implements used in the manufacture of lacquer ware, given in Mr. Quin's report, we are let into the secret of the manner in which strength is given to wood to prevent splitting. Thus hempen cloth is pasted or glued over the wood, and this is also applied to the corners of the various articles. For very fine work and small articles silk is used, the whole being covered with successive coats of lacquer, but the texture of the cloth is lost. For drying the articles, a cave or underground cellar is used where practicable, otherwise an air-tight case made of wood, with rough unplained planks inside. These are thoroughly wetted before the lacquered article is put in to dry, which occupies a period varying from six to fifty hours, according to the time of the year or style of the lacquer. Lacquer will not dry or harden properly in the open air; it absolutely requires a damp close atmosphere to do so, otherwise it would run, and always remain sticky.

The following is given as to the mode of proceeding under the term of *Honiji*, or real basis:—

1. The article to be lacquered is first carefully smoothed.

2. The wood is slightly hollowed away along each joint, so as to form a circular depression.

3. The surface of the whole article is then given a coating of branch lacquer (this is called *ki-ji-gatame*, hardening the wooden basis), and the article set to dry in the damp press for about twelve hours.

4. The hollowed portions are filled with prepared *kokuso*, which is well rubbed in with a spatula made of the wood of *Chamæcyparis obtusa*, and the article is enclosed in the drying press for a period of at least forty hours.

5. Over the *kokuso* a coating of *sabi* is applied, and set to dry for twelve hours.

6. The next process is to smooth off with a white whetstone any roughness or inequalities of the *kokuso* and *sabi*.

7. The article is then given a coating of wheaten lacquer, over which is stretched hempen cloths, great care being taken to spread it smoothly, and leave no wrinkles or perceptible joinings, and it is then again inclosed in the drying press for about twenty-four hours.

8. After taking the article out of the press all inequalities in the cloth—which has now, under the influence of the lacquer become harder than wood—are smoothed down with a knife or plane.

9. Next a coating of *sabi* is applied with the spatula to hide the texture of the hempen cloth, and the article is again put in the press for twenty-four hours.

10. Next a coating is given of *Jinoko* (powdered burnt clay, and branch lacquer mixed in the proportion of one part of clay and two parts of lacquer), applied with a spatula, after which the article is enclosed in the drying press for twenty-four hours.

11 and 12 are repetitions of the same process.

13. Next the article is given a coating of *kiriko* (a mixture of *Jinoko* and *Tonoko*, a fine kind of clay, burnt and reduced to a very fine powder), likewise applied with a spatula, and the drying process is repeated for 24 hours.

14. Is a repetition of the same process, after which the article is set to dry for at least three days.

15. The surface is next ground smooth with a fine whetstone.

16. A hardening coat of branch lacquer is given with a spatula, and set to dry for twenty-four hours.

17. A fresh coat of *sabi* is applied with the spatula, and the article is put to dry in the press for twenty-four hours.

18. When thoroughly hardened, the surface is ground smooth with a white whetstone, as before.

19. Next a thin coating of branch lacquer is applied with the spatula, and the article is set to dry in the press for twelve hours.

20. A coating of *naka-nuri* (crude lacquer) is then applied with a flat brush, and the article set to dry again for twenty-four hours.

21. On being taken out, the surface is ground smooth with charcoal, made from *Hōno-ki (Magnolia hypoleuca)*.

22. A thin coating of branch lacquer is given with cotton wool—old wool being chosen, because less likely to leave hairs behind it—and rubbed off again with soft paper, after which the article is set to dry for 12 hours.

23. A coating of *Ro* (black lacquer) is then applied, and the article is set to dry for 24 hours.

24. The surface is rubbed smooth with a piece of charcoal made from *Hiyakujikko* (*Lagerstrœmia indica.*)

25 and 26 are repetitions of 23 and 24.

27. The surface is partly polished with finely powdered *Lagerstrœmia* charcoal, applied with a otton cloth.

28. A coating of *Ro* is applied very thinly, with cotton wool, and this is rubbed off again with soft paper, after which the article is enclosed in the drying press for 24 hours.

29. The surface is now polished with an equal mixture of powdered burnt clay from Mount Mari (*To-no-ko*), and calcined deer's horn ashes, applied with a cotton cloth, and a little oil made from *Sesamum indicum*, till a fine polish is obtained.

30.—A coating of branch lacquer is next given, applied with cotton wool, very thinly, and the article is enclosed in the drying press for 12 hours.

31. The workman dips his finger in oil, and rubs a small quantity of it over the surface, which he then polishes with deer's horn ashes, applied with a cotton cloth, till a bright surface is obtained.

32. A coating of branch lacquer is applied, as in No. 30, wiped off with soft paper, and set to dry for 12 hours.

33. The oil is applied as in No. 31, and then a final polishing with deer's horn ashes given with the finger to the surface, which now assumes the most brilliant polish of which it is capable.

For articles that are liable to get rubbed, such as scabbards, these last two processes are repeated seven or eight times, the surface getting harder at each repetition, but this is not necessary for other articles, even of the best quality. In describing the above processes, the minimum time for drying has in each case been given, but for the first twenty-five processes the longer the article is kept in the press the better. From the twenty-eighth process to the finish it is better not to greatly exceed the times mentioned.

These processes, which are apparently essentials for plain lacquer work, are, as will be seen, very tedious, occupying a considerable time in drying. In coloured and gold lacquer the processes vary slightly, and are even more lengthy and complicated, very great care being exercised in tracing and completing the design, the plants and flowers represented being almost botanically accurate. The picture to be transferred to the article is drawn on thin paper, to which a coating of size, made of gum and alum, has been applied. The reverse is rubbed smooth with a polished shell or pebble, and outline very lightly traced in lacquer (previously roasted over live charcoal to prevent its drying) with a fine rat's-hair brush. The paper is then laid with the lacquer side downwards on the article to be decorated, and is gently rubbed with a whalebone spatula, wherever there is any tracing, and, on removing the paper, the impress may very faintly be perceived. To bring it out plainly, it is rubbed over very lightly with a piece of cotton wool, charged with powdered white whetstone or tin, which adheres to the lacquer. Japanese paper being peculiarly tough, upwards of twenty impressions can be taken from one tracing, and when that is no longer possible, from the lacquer having become used up, it only requires a fresh tracing over the same paper to reproduce the design *ad infinitum*. This tracing does not dry, owing to the lacquer used for the purpose having been partially roasted, and can be wiped off at any time.

The next process is to trace out the veining of the leaves, or such lines to which in the finished picture it is desired to give the most prominence, and these lines are powdered over with gold dust through a quill; the article is then set to dry for twenty-four hours in the damp press. The outline is now drawn carefully with a rat's-hair brush, over the original tracing line, with a mixture of black and branch lacquer, called *Rô-se*. The whole is then filled in with *Rô-se*, applied with a hare's-hair grounding brush; a coarse kind of gold dust is then scattered over the lacquered portion, and the article is set to dry for twenty-four hours. Another thin coating of *Rô-se* lacquer is applied over the whole surface of the article, which is set to dry for at least three days. It is then roughly ground down with magnolia charcoal, the surface dust being continually wiped off with a damp cloth, till the pattern begins to appear faintly. Another coating of black lacquer is then given, and the article set to dry for thirty-six hours. It is again ground down with magnolia charcoal as before, this time till the pattern comes well out. Besides this, there are distinct processes for flat gold lacquer, raised gold lacquer, and lacquering on metal, all of which are described in Mr. Quin's report.

In the district of Aidzu the light-coloured lacquer articles are produced in the greatest perfection, viz., yellow, green, and intermediate shades. In Tôkiô, though the same materials are used, the resulting colours are inferior and darker. In Aidzu no after polishing takes place with coloured lacquers. The lacquer is applied like paint. Tôkiô is, however, best for black lacquer as well as for such high class red, &c., as are polished afterwards. These differences are attributed to some climatic influence. The *Kioto*, so-called "black lacquer," shows a reddish brown tinge. With the exception of Tôkiô, Kioto, Osaka, Kaga, Tsugaru, Wakasa, Nagova, Suruga, Shidzuoka, and one or two isolated places, the method of smoothing with charcoal and afterwards polishing, is not pursued. In Tsugaru and Wakasa neither flat nor raised gold lacquer are made. It should be mentioned that the plain lacquered articles are almost exclusively manufactured by one set of workmen, who supply the workers in gold lacquer with the articles ready for the application of the gold powdering, various patterns, &c.

The wholesale lacquer trade is in the hands of a few large merchants. In Tôkiô there are two houses only. These receive the crude lacquer from the producers as it arrives from the various districts, either buying it outright, or making advances to the contractors, who are bound, by the rules of the guild, to deliver only to them. They sell it in quantities, as required, to the lacquer manufacturers, who prepare and refine the sap for the market, and these again retail the material to the lacquer workers. The various processes the lacquer undergoes in the hands of these manufacturers, before retailing, are kept secret, only the approximate mixtures being known. That all lacquer, even that sold as pure lacquer, undergoes some adulteration, is rendered evident from the fact that, in accordance with a strange custom peculiar to the lacquer trade, the retail manufacturers sell even the smallest quantity at the same rate at which they buy it from the wholesale merchant.

Regarding the use of colours in the lacquer work, Mr. Quin says, "It is a remarkable fact that (as I am informed) no vegetable colours can be used with lacquer. They are all eaten up, as it were, by the lacquer, and disappear, which accounts for the very few variations seen in the colours of lacquer. The workmen have never been able to produce white, purple, or any of the more delicate shades. Of late years, since cheap work has been introduced, the custom of using the dust has been adopted for making common *Nashiji*. It is manufactured of the same sizes as in gold and silver, and when plenty of gamboge is mixed with the lacquer to cover it, an inexperienced person might easily mistake it for gold when the ware is new, but it soon deteriorates. Burnt tin dust is also sometimes used for under coats in making cheap raised lacquer."

The whole report is one of extreme interest, containing, as it does, a mass of valuable information never before published.

THE PROGRESS OF OUR SHIPPING AND CARRYING TRADE.[*]

In the discussions that have lately taken place on our national condition, prominence has been given to the progress of our shipping, to the predominance of our carrying trade, and to the large part it plays as a practical portion of our export business. Mr. Robert Giffen, Mr. John Glover, Mr. Stephen Bourne, and the late Mr. Wm. Newmarch have devoted special consideration to these topics. It is impossible, indeed, to form any true estimate of our imports and exports, and of our national industry, without taking this powerful element into account. It is in consequence of its importance that some observations are now made in further illustration of the true bearings of the inquiry. For the present purpose, broad general figures will suffice, for it is not necessary to enter into the vexed questions of the unit of tons to be computed, &c. We may take some few broad facts, and Mr. Glover's paper in the *Journal of the Statistical Society* this year will be a convenient basis of reference.

He states the total tonnage entered and cleared at ports in the foreign trade only as follows:—

1850	14,000,000 tons.
1860	24,000,000 ,,
1870	36,000,000 ,,
1880	58,000,000 ,,

Thus the increase in thirty years was fourfold. The same result is obtained if vessels with cargoes are alone taken. If we take the English tonnage engaged in this trade, we find—

1850	9,000,000 tons.
1860	14,000,000 ,,
1870	25,000,000 ,,
1880	41,000,000 ,,

The amount of foreign tonnage engaged in this trade increased only fourfold. A notable fact is that our steam tonnage largely increased in this epoch.

Thus we have to deal with two leading classes of facts. First, the increase of our shipping trade; second, the development of our steam marine.

In considering the nature of the growth of our trade, and that of other countries, we must take into account the development of the world within the last forty years. This includes the enlarged territory and production of North America; the advance of South America; the practical opening of Africa, West and South; the growth of the Australian Colonies; and the increasing Indian produce by railways.

The most striking fact is, however, the throwing open of the Pacific world. Fifty years ago, there was little but the China trade under the East India Company; and China and Japan have now been made accessible to commerce. South Australia has already been referred to. The discovery of gold in California and Australia, however, gave a special impulse to all enterprise in that ocean. On the West Coast of South America, Peru and Chile gave large cargoes of guano, nitre, wheat and copper. If nothing else had occurred in the world, the vast expansion of trade in the Pacific must have produced great effects, and at least doubled the trade of the world. Under most circumstances, the distribution of this increase of trade would have taken place among the carrying nations, but steam and iron have created a vast revolution in all shipping arrangements.

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[*] Paper read before the Economic Section of the British Association, at Southampton, by Hyde Clarke, Vice-President of the Section for Economic Science and Statistics.

Forty years ago, steam played but an inconsiderable part in foreign trade. Sailing ships, or steamers with wooden hulls, were made with the timber of the United States, Canada, Norway, and Russia, and were fitted with the hemp of Russia and other countries. Our materials for ship equipment were chiefly imported from abroad, and we had to pay the foreigner for them, while the foreigner had great advantages for engaging in the same enterprises.

Now, the hulls are made of iron and steel, the rigging and cable also; the engines are of metal, and a chief working material is coal. As all these articles, so far as we are concerned, are of home production, we no longer have to import them, we no longer have to pay a tax for acquiring them, and we turn to account the products of our own soil. The foreigner is seldom able to compete with us. The Americans, who had the advantage of home timber, have lost that resource, and their home iron is produced under less favourable circumstances.

Thus, by the addition and application of steam, in iron and steel vessels, the economical conditions of our shipping trade have been greatly altered; and, inasmuch as the trade of the world has expanded, so do we obtain not only our share of the increase of this trade, but a share enhanced by our possession of advantages in the new mode of carrying.

This fourfold advance cannot be due to free trade, which did not create the gold diggings, or bring into action most of the other favourable circumstances; nor is this advance due to fair trade or protection, as neither has done anything, nor could have done anything, to promote the operations which have taken place. It is, therefore, worthy of consideration, whether the discussion of the systems of free trade or fair trade has done any good in the determination of the real issue, and whether we should not better direct our attention to the true causes affecting our national prosperity. While partisans have been engaged in violent contests, the development of our national resources in the right and practical direction has been unduly neglected.

JAVANESE MUSICAL INSTRUMENTS.

In the *Journal* for September 29, some account was given of the musical instruments of the Javanese. It was stated that, while the pentatonic system of the *Gamelan Salindro* is unmistakeable, that of the *Gamelan Pelok* was somewhat a puzzle. Further study of the instruments has explained how it arose. In the *Slentem Pelog* and in the *Peneros*, which, as described, consist each of groups of fourteen "bells," the position of some of the bells is sometimes changed for convenience, apparently that those which were much used in any particular pitch may be close together. Herr Walkert, who has brought the Javanese to Europe, is not a musician, and although most ready to interpret questions to the Javanese and their answers, it is now evident that some of the questions have been misunderstood. The difficulty is further increased from the fact that, just as there is no word for music, so the notes do not seem to have names. There are names for the plates and the bells, for the small as well as the large bells, though till a few days ago it was said there were not. The names, from left to right, in the instruments of the *Gamelan Pelok*, run thus:—*Bem*, *Pengulu* (or *Pengœlœ*), *Penœlœ*, *Pelok*, *Limo*, *Nenem* (or *Gnum*), and *Bavang*, and these apply to the metal plates of the *sarons*, the wood plates of the *kambang*, and the "bells." In the *Gamelan Salindro* (the pentatonic system) there is no *pelok* and no *barang*. The word *barang*, is, however, introduced as an adjective. Thus the low *bem* in each *saron* is called *bem bazzan*, and the octave above, *bem barang*. So far all is simple, and the *bem* of the *Gamelan Pelok* is the same note as the *bem* of the *Gamelan Salindro*. But the *limo* of the *Salindro* corresponds to the *nenem* of the *Pelok*, and the *penœlœ* of the *salindro* is the same as the *pelok* of the *Gamelan Pelok*. Thus, though there is no *pelok* plate in the *salindro* sequences—and, it was said, this chiefly distiguished the *salindro* from the *pelok*—there is the same note, but called in one case, *pelok*, and in the other, *penœlœ*. By the aid of diagrams, and writing the names, it is clear all the men agree on these points, and it is easy to make them understand that you recognise the same note or sound (*buni*) from the *Salindro Limo* as from the *Pelok Nenem*. As for any name for the notes, corresponding to our *do*, *re*, *mi*, they do not seem to have any. Though their ears are so wonderfully acute, though they are excellent timeists, can play a piece twenty minutes long and complicated in structure, and though music has been cultivated by the nation for thousands of years, they have no names for their notes, and no notation.

Another difficulty stood in the way of understanding the system of the *Gamelan Pelog*. As stated in the previous article, the *Kambang Pelog* has nineteen wooden plates; but it was noticed there were others lying about, and sometimes some of these were used. At first Herr Walkert said he understood that was to prevent certain notes that were much used from being too much worn. But it was then noticed that the substituted plates were not the same note as those that were removed. The men either could not or would not explain what the changes were. It has been suggested that, as the music is handed down traditionally, those initiated to the "secrets" are not allowed to divulge them. Be this as it may, by using diagrams, and "dodging the question," as schoolboys would say, this was made out after many attempts. The fifth, tenth, and fifteenth plates are removed from the *Kambang Pelok*, and fresh plates are substituted. The *Kambang Pelok* is then called *Kambang Sarok* (which means shifted), the scale has been changed. The fourth, ninth, fourteenth, and nineteenth remain octaves as before. Again, there is another change, Nos. three, eight, and thirteen, are removed, and four, nine, and fourteen, are shifted into their place. The *Sorok*, five, ten, and fifteen are shifted to four, nine, and fourteen, and fresh five, ten, and fifteen, are put in. Here is quite another scale, and the *Kambang* is then called *Kambang Sorok Barang*. There is also another change, which makes the *Kambang Sorok Danso*. After this was understood, and the men admitted the diagrams were correct, the shifting of the bells became intelligible. The *Barang* bells are used only when the *Barang* plates are in the *Kambang*, and so on. They are not actually removed from the frame, but for each piece the bells that have to be used are kept, as much as possible, in the middle, as the frames are over seven feet long. The *Gamelan Pelog*, therefore, it comes out, has four scales, and what some musicians at first set down to hap-hazard, is in accordance with the delicacy of these systems.

In the *Peneros* the fourteen bells are in two rows, one called *wedok* (female), and the other *lanang* (male). Similarly, in the *Bonang* there are two rows. The *wedok* row of the *peneros* has the bells of the same pitch as the *lanang* row of the *bonang*, but the bells are differently shaped, and the timbre is different. There is no word for octave, but the bells that are octaves are called *koempoel* (couples). The intervals in the *Gamelan Pelok* have been approximately ascertained with a standard set of tuning forks, and with a flute of known pitch; but as they do not correspond with ours, it is but an approximation. The *Pengulu* of the *Gamelan Pelog* is a C rather sharp; the *Penelu*, a D rather flat; *Pelok*, a good F; *Limo*, a flat F sharp; *Nenem*, something between G to G sharp; *Barang*, A flat, and *Bem*, between a very sharp A flat and B. Perhaps, with a siren, it may be possible to get them with exactness, but there are difficulties with percussion instruments. The scales are:—

PELOK ...	Pengulu	Pelok	Limo	Nenem	Bem
SOROK DANSO ...	Pengulu	Penelu	Nenem	Barang	Bem
SOROK BEM	Pengulu	Penelu	Limo	Nenem	Bem
SOROK BARANG	Pengulu	Penelu	Limo	Nenem	Barang

Nothing has been written on the Javanese systems, and as the bells are peculiar to the nation, it would be a pity not to learn all that can be learnt.

THE LANCASHIRE "PLATEWAY."

The Liverpool correspondent of *The Times* gives the following account of a new engineering project, designated "The Lancashire Plateway," which aims at nothing less than the complete revolutionising of the inland transit of merchandise. The introductory step is to raise a fund of £75,000 for surveys, preliminary expenses, and Parliamentary charges; and more than half this amount is said already to have been subscribed. Broadly, the proposal is to lay out a series of roadways, radiating from Liverpool to the centres of manufacturing industry in South Lancashire, to carry along these roadways a double set of iron plates, corresponding in breadth with the wheels of ordinary lorries or wagons, to set the loaded wagons on this smooth plateway, and draw them by steam traction engines to their appointed destination. Passenger traffic is excluded from the scope of the scheme; it is confined entirely to goods, and the anticipation is that it will be possible to carry these at a much lower rate than is now charged by the railway companies. The movement has its origin and motive in the burdensome charges now levied.

The common impression is that railways have both cheapened and accelerated traffic; but such has not been the experience on the main route of South Lancashire. It may appear to be rather a startling fact, yet it is distinctly affirmed that the present cost of sending a bale of cotton from Liverpool to Manchester, by railway, is actually greater than was charged before railways were constructed, and when the conveyance was by canal, or by horse haulage along the highway. Nor is the speed materially quickened. In the old days the journey was completed overnight, so that goods despatched in the evening were delivered early next day; and the railways now do nothing better than this. The loss of time occurs in the handling of the goods at either terminus, and the frequent transhipment they must undergo before being delivered. In the same way, a very large proportion of the expense of railway transit arises from the "terminal" charges—that is, the the labour and trouble of loading and unloading the wagons, and marshalling the trains ready for despatch at the one end, and for delivery at the other. The plateway proposes to supersede these terminal charges altogether, and to dispense with the intermediate handling of the goods, as well as to reduce haulage cost to a point far below anything that the railways can compete with. To understand the character of the change, it may be well to explain the railway system as it now exists, and then to compare it with the plateway system as intended to be established. Take the progress of a bale of cotton from the shi to the mill, as an illustration of the prevailing practice. It is lifted out of the ship's hold, deposited on the quay, again lifted on to a cart, and taken either to a warehouse or the railway station. Arrived at the station, it is once more unloaded from the cart, accumulated in convenient piles in the depôt, and finally placed on the railway truck, which, after a long succession of shuntings, is marshalled into its proper train, and is then ready to begin its journey to Manchester. At that end an almost similar process has to be gone through.

The process of the plateway will be infinitely simpler, and, therefore, proportionately cheaper. The bale will be loaded on to the appointed wagon at the ship's side or at the warehouse door, the wagon will be drawn by horses to the nearest station of the

Plateway Company, it will be linked on to a long train of other similar wagons, a steam traction engine will be placed at the head of the train, and it will haul the whole train of vehicles along the smooth plateway to the appointed destination. At the further end of the plateway, the traction engine will be disconnected, horses will be yoked to the wagons, and they will at once be drawn to the mill yard. By this treatment all the labour and expense of transhipments will be obviated. The same vehicle that receives the cotton at the Liverpool dock or warehouse will deliver it into the mill without any intermediate handling. This will be a palpable economy. In the case of manufactured goods it will also be a great advantage in the avoidance of the damage now inseparable from rough usage on the railway. But the dispensing with frequent handling is not the sole element of economy. It is proposed to carry the plateway into the outskirts of all the principal manufacturing towns of South Lancashire; at each there will be a stud of horses to take up the work, and thus the plateway wagons will be drawn into each mill yard without loss of time or cumulative charges.

Having now explained the theory of the plateway, it is necessary to see how it is to be applied in practice. Its fundamental principle is that the goods shall never be unloaded or shifted from the wagons in which they are placed from the beginning of the journey until they reach their final destination. If a bale of cotton is loaded at Liverpool, it shall remain in the same condition until it is delivered into the mill at Oldham or Blackburn; if a bale of manufactured goods is sent from these towns for shipment abroad, it shall remain similarly undisturbed until lifted into the ship's hold in Liverpool. This result is to be attained by a very simple process. The wagons or lorries will be similar in construction to those now universally used in Lancashire; the only difference will be in their wheels. The front and rear axles will be of identical width, and of the same gauge as the plateway, but in all other respects the vehicles will be suitable to ordinary roadwork. The plateway will consist of two parallel rows of metals running along the prepared highway. The metals or plates will be about five inches in depth, and along the smooth surface the wagon wheels will run with ease and freedom. On the outer edge of the plates will be a raised flange, strong enough and high enough to prevent the train from leaving the track. In fact, the accustomed railway track is simply reversed. There the rail is flat, and the retaining flange is placed on the wheel; in the plateway the rail or plate carries the flange, and the wheel is flat. The original idea of the promoters was to utilise the ordinary highways for this system of goods traffic, but insuperable difficulties presented themselves, and it is now proposed to acquire land and lay down a special track for the plateway, similar in all respects to the ordinary railways. There will be no necessity, however, to make the permanent way of so substantial construction, or to have the levels so exact as in the case of railways. Although the estimates are still in a very crude form, it is calculated that the plateway can be constructed and equipped at an average cost of £35,000 per mile; if so, the capital will be insignificant in comparison with that embarked on the railways in the same district. This greater cheapness will allow of lower charges, and another substantial gain will be in the smaller working charges. As there will be no passenger traffic, and as the rate of speed for the trains will be comparatively slow, there will be little or no expense in signalling, and the road staff will be slight. The enormous expense of establishing stations in the centre of all the large towns (as in the case of railways) will also be avoided, because the depôt may be located in the outskirts. This arrangement will only necessitate the haulage of horses for a little greater distance, and will constitute no appreciable addition to the expense of working.

The scheme, as mapped out by the projectors, covers a large portion of the busiest manufacturing districts of Lancashire. The present proposal is to lay down 133½ miles of plateway, at a rough estimate costing about four and a half millions of money. There are two main routes, one starting from the south end of Liverpool, and running to Oldham, *viâ* Warrington, touching the south side of Manchester, and taking in Ashton and Staleybridge. The other route starts from the north end of Liverpool, touching St. Helen's, Ashton-in-Makerfield, Bolton, Bury, Heywood, and Rochdale, and, like the other line, terminating at Oldham. There will also be subsidiary lines leaving the main road at convenient points, and branching off to Burnley in one direction, and Preston in another. It will thus be seen that some of the principal manufacturing centres of Lancashire are tapped by the plateway, and brought into direct communication with Liverpool. As regards the traffic that now passes between these several points, it is almost impossible to obtain trustworthy statistics. But some idea of the magnitude of the goods traffic of the district may be formed from the fact that every day about 35,000 tons of goods pass through Liverpool; and, unquestionably, a very considerable proportion of it originates with the districts proposed to be served by the plateway. Those who have taken up the subject are confident not only that the scheme is practicable as an engineering work, but hopeful of success as a commercial adventure. This confidence certainly displays itself in a practical form when the preliminary surveys have been completed, a Bill drawn for introduction into Parliament next Session, and a large guarantee fund already subscribed, not by a speculating syndicate, but by men of the highest repute in the commercial world. The originator of the project is Mr. Alfred Holt, of Liverpool, who, besides being a large owner of steamers trading to India and China, is also a trained civil engineer. He has been working at the project assiduously for two years.

Correspondence.

PUBLIC HEALTH.

I observe, in a recent number of the *Journal*, (see ante p. 1044), a letter from Mr. Bischof, alluding to a statement I made in my address to the Sanitary Congress at Newcastle, that the river Seine at Paris became comparatively purified after a certain length of flow; and expressing an opinion that any alteration in the appearance of the river below Paris was due to mechanical subsidence and not to chemical action. The statement was derived from the report of the Commission which examined the condition of the river Seine in 1875-76. The following are the facts in the report. Above Paris, the Seine presents a satisfactory appearance. The sewers of Paris discharge black fœtid streams into the river, forming shoals of mud, which are the seat of active fermentation. Fish and plants cannot exist. Below Paris, the river gradually improves. The following table shows the chemical state of the water:—

Place.	Nitrogen not yet transformed into volatile ammoniacal salts or organic nitrogen. Grammes per cubic metre.	Total nitrogen including volatile ammoniacal salts. Grammes per cubic metre.	Dissolved oxygen in cubic centimetres per litre of water.
Above Paris.			
Bridge of Asnières	0·85	1·5	5·34
In Paris.			
Clichy, below intercepting sewer	1·51	4·0	4·60
St. Denis, below intercepting sewer	7·27	7·0	1·02
Below Paris.			
Meulan	0·40	2·2	8·17
Vernon	0·40	1·4	10·40

The table explains the process which takes place. The organic matters change into carbonic acid, water, ammonia, sulphurette, hydrogen, and various mineral substances. This change implies an absorption of oxygen from the gases dissolved in the water, and a production of mineral nitrogenous substances. When fermentation is accomplished, and the organic matter has passed into mineral matter, the water presents a disappearance of nitrogenous organic matter, replaced by nitrogenous mineral matter. The dissolved oxygen in the water is used up, but may be restored by movement, such as is caused by the flow of the stream, or by passing over a weir.

Mr. Bischof also inquires whether I was conversant with the case of the outbreak of fever at Caterham; in reply, I beg to say that I was quite aware of the report made by the officers of the Local Government Board upon that epidemic.

DOUGLAS GALTON.

12, Chester-street, S.W., 30th October, 1882.

Obituary.

CHARLES EDWARDS AMOS.—Mr. Amos, who died on the 12th August last, was for many years a member of the Society of Arts, and in 1873-75, he served as a member of the Committee of the Society appointed to consider the subject of Traction on Roads. He devised and constructed a special dynamometer for testing the tractive force required on various pavements in London with a given load, and also arranged a series of experiments with the instrument. Mr. Amos was born 27th November, 1805, and from a child showed a special taste for practical mechanics. In 1836, he entered into partnership with Mr. James Easton, and the two commenced business as millwrights, engineers, and lead pipe manufacturers. In 1843, he was elected a member of the Society of Arts; and in 1849 he received from the Royal Agricultural Society a special gold medal for his dynamometer, which was used at the Norwich show in 1849.

General Notes.

AMERICAN PATENTS.—The report of the Commissioner of Patents at Washington, for the fiscal year ending June 30th of this year, shows that the number of applications for patents during that period was 28,883. The number of patents granted was 17,713. The receipts of the office for fees, &c., were 930,864 dollars, and the expenditure (not including printing), 651,719 dollars. The commissioner recommends that an Act of Congress should be passed, to determine the length of time for which a patent may be issued for an invention already patented in a foreign country.

THE TEXTILE INDUSTRY AT MULHOUSE.—According to the last Annual Report of the Mulhouse Chamber of Commerce, the industry of that city is in a relatively favourable position. Within the district represented by that body, there are 63 weaving establishments, containing a total number of 14,555 looms, and 43 spinning-mills, representing 921,236 spindles. There existed likewise, in 1881, 4 factories of twisted yarn, 8 chemical bleaching works, 17 print works, and 12 dyeing establishments. The annual consumption of raw cotton amounted to 17,000 tons; in addition to which over 500 tons of cotton and woollen yarn were also used.

THE LIBRARY.

The following works have been presented to the Library:—

The Home Colony; a Guide for Investors and

Settlers in Newfoundland. By E. Hepple Hall. (London: Edward Stanford.) Presented by the Author.

The Hall-marking of Jewellery practically considered. By George C. Gee. (London: Crosby Lockwood and Co. 1882.) Presented by the Publishers.

Worked Examination Questions in Plane Geometrical Drawing. By F. Edward Hulme. (London: Longmans, Green and Co. 1882.) Presented by the Publishers.

Art Instruction in England. By F. Edward Hulme. (London: Longmans, Green and Co. 1882.) Presented by the Publishers.

The Papers of the Eclectic Discussion Society. Edited by Henry Walduck. (London: Elliot Stock. 1882.) Presented by the Publisher.

Faith: the Life-Root of Science, Philosophy, Ethics, and Religion. By H. Griffith. (London: Elliot Stock, 1882.) Presented by the Publisher.

Tenth Annual Report of the Local Government Board, 1880-81. (London. 1882.) Presented by the Board.

British Rainfall; 1881. By G. J. Symons, F.R.S. (London: Edward Stanford. 1882.)

A Treatise on the Transit Instrument as applied to the determination of Time. By Latimer Clark. London. 1882.) Presented by the Author.

On the Preservation of Life and Property from Fire. By James H. Heathman. (London; Simpkin, Marshall and Co. 1882.) Presented by the Author.

Dangers to Health: a Pictorial Guide to Domestic Sanitary Defects. By T. Pridgin Teall, M.A. (London: J. and A. Churchill. 1881) Presented by the London Sanitary Protection Association.

London Water Supply. Report to the President of the Local Government Board on the Composition and Quality of Daily Samples of the Water Supplied to London from December 20, 1880, to July 31, 1882. Nos. I–XX. By William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B. Presented by the New River Company.

Elementary Decoration: a Guide to the simpler form of Everyday Art, as applied to the Interior and and Exterior Decoration of Dwelling Houses. By James W. Facey, Jun. (London: Crosby Lockwood and Co. 1882.) Presented by the Publishers.

Manual of Colours and Dye Wares. By. J. W. Slater. (London: Crosby Lockwood and Co. 1882.) Presented by the Publishers.

The Action of Lightning, and the means of Defending Life and Property from its Effects. By Arthur Parnell. (London: Crosby Lockwood and Co. 1882.) Presented by the Publishers.

A New Classified Catalogue of the Library of the Royal Institution of Great Britain. By Benjamin Vincent. Vol. II., including the additions from 1857, to 1882. (London: 1882.) Presented by the Managers of the Royal Institution.

Familiar Lessons on Food and Nutrition; intended to serve as a handbook to the Food Department of the Parkes Museum of Hygiene. By Thomas Twining. Part I. (London; David Bogue. 1882.) Presented by the Author.

Report from the Committee of the Technical College at the Sydney Mechanics' School of Arts. (Sydney: 1881.) Presented by Thomas Twining.

The Open Fireplace in all Ages. By J. Pickering Putnam. (Boston: James R. Ozgood and Co. London: Trübner and Co. 1882.) Presented by Messrs. Trübner and Co.

The Land of the White Elephant. By Frank Vincent, jun., M.A. (New York: Harper and Brothers. 1882.) Presented by the Author.

Extracts from the Minutes of Proceedings of Civil Engineers, &c., relating to the laying of the first Submarine Telegraph. Presented by Thomas R. Crampton.

Natal: Department of Mines. Report upon the Coalfields. By Frederic W. North. (London: 1881.) Presented by the Author.

Calendar and Syllabus of Lectures, &c., of the Watt Institute and School of Arts for 1882-3. (Edinburgh: 1882.) Presented by Lord Shand.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 6...Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. S. B. L. Druce, "Farm Tenancies."

Royal Institution, Albemarle-street, 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Carl Pieper, "Ice Machines and Refrigerators."

British Architects, 9, Conduit-street, W., 8 p.m. Opening Address by the President, Mr. Horace Jones.

Society of Chemical Industry, Burlington-house, W., 8 p.m. 1. Prof. Abel, "The Floshing Test for Petroleum." 2. Mr. Weldon, "A New Process for the Manufacture of Sodium Sulphide and Potassium Sulphide."

TUESDAY, Nov. 7...Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Biblical Archæology, 9, Conduit-street, W., 8½ p.m. 1. M. Eugène Révillout, "A Demotic Papyrus containing the malediction of an Egyptian mother on her son embracing Christianity," and "Two Demotic documents of the reign of Darius, referring to a marriage contract." 2. Mr. Theo. G. Pinches, "Some recent discoveries bearing on the Ancient History and Chronology of Babylonia."

WEDNESDAY, Nov. 8...Microscopical, King's College, W.C., 8 p.m. 1. Mr. T. B. Rossiter, "Observations on Stephanosceros." 2. Dr. Maddox, "Some Organisms found in the Excrement of the Domestic Goat and the Goose."

THURSDAY, Nov. 9...Society of Telegraph Engineers and of Electricians, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Preece, "The Munich Electrical Exhibition, 1882."

FRIDAY, Nov. 10...Sacred Harmonic Society (at the HOUSE OF THE SOCIETY OF ARTS), 7 p.m.

SATURDAY, Nov. 11...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. S. P. Thompson "Three Historical Notes on Physics." 2. W. R. Browne, "Conservation of Energy and the Theory of Central Forces."

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FRIDAY, NOVEMBER 10, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The first meeting of the One Hundred and Twenth-ninth Session of the Society will be held on Wednesday, the 15th November, when the Opening Address will be delivered by Charles William Siemens, D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be five ordinary meetings, in addition to the opening meeting.

Candidates proposed for election as members are privileged to attend the opening meeting.

The following arrangements for the Wednesday evenings before Christmas have been made:—

November 15.—Opening Meeting of the Session. Address by C. W. Siemens, D.C.L., LL.D., F.R.S., Chairman of the Council.

November 22.—"Ice-making and Refrigerating." By J. Hopkinson, D.Sc., F.R.S.

November 29.—"The Manchester Ship Canal." By W. K. Johnson, B.Sc.

December 6.—"The Artificial Drying of Crops." By William A. Gibbs.

December 13.—"Electrical Exhibitions." By W. H. Preece, F.R.S.

December 20.—"The Utilisation of Waste. A Retrospect of Recent Progress." By P. L. Simmonds.

At the meetings after Christmas the following papers (among others) will be read:—

"The Sanitary Inspection of Houses." By W. K. Burton.

"The Modern Lathe." By J. H. Evans.

"Collisions at Sea." By Captain J. H. Colomb, R.N.

"The History of the Pianoforte." By A. J. Hipkins.

"The Construction of Torpedo Boats." By J. Donaldson.

"Technical Aspects of Lignification." By C. F. Cross, F.C.S.

"Self-purification of River Waters." By W. N. Hartley, F.R.S.E.

"The Application of Electrolysis to Bleaching and Printing." By James J. Dobbie, D.Sc., and John Hutchinson.

"The Electrical Transmission of Power." By Prof. George Forbes.

"Egypt: Present and to come." By Robert W. Felkin.

"New Zealand." By W. Delisle Hay.

"The Mauritius." By the Rev. J. Sibree.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 30; February 27; March 20; April 3; May 1, 29.

Applied Chemistry and Physics Section.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 25; February 22; March 8; April 12, 26; May 24.

Indian Section.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 16; March 2; April 6, 20; May 4, 25.

Cantor Lectures.

The First Course will be on "Dynamo-Electric Machinery." By Prof. Silvanus P. Thompson, D.Sc.

December 4, 11, 18.

The Second Course will be on "Solid and Liquid Illuminating Agents." By Leopold Field.

January 29; February 5, 12, 19, 26; March 5.

The Third Course will be on "The Decorative Treatment of Metal in Architecture." By George H. Birch.

April 2, 9, 16.

The Fourth Course will be on "The Transmission of Energy." By Osborne Reynolds, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

April 23, 30; May 7.

The Fifth Course will be on "Secondary Batteries." By Prof. Oliver J. Lodge, M.A., D.Sc.

May 21, 28.

Juvenile Lectures.

The two Juvenile Lectures will be by Prof. Henry Nottidge Moseley, M.A., F.R.S., on "The Inhabitants of the Ocean." The dates for these are Wednesday evenings, the 3rd and 10th January. The lectures will commence at 7 o'clock. Special tickets will be issued for these lectures, due announcement of which will be made.

ADMISSION TO MEETINGS.

Members have the right of attending all the Society's meetings and lectures. They require no tickets (except for the Juvenile Lectures), but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

ANNUAL GENERAL MEETING.

The Annual General Meeting will be held on Wednesday, June 27 at four o'clock.,

Correspondence.

PUBLIC HEALTH.

Several exceptions might be taken to the table which Capt. Galton has kindly given on p. 1075 of the Society's *Journal;* but we will suppose that the figures in the two first columns correctly represent organic nitrogenous contamination of some kind. Between St. Denis and Meulan the Seine is joined by the Oise, a by no means inconsiderable river, in proportion to the volume of the Seine. This new element renders it impossible to refer to the relative state of the Seine at St. Denis and Meulan as an instance of the hypothetical power of "self-cleansing." But even if the body of water which is contaminated at St. Denis were not diluted by the Oise, the table would not justify the conclusions drawn by Capt. Galton; for, taking the largest pollution shown in the first column, viz. 7·27, we are told that the water at that point contained the minimum of oxygen, and, that by the time the river reaches Meulan, the oxygen is increased eight times. We cannot conclude from such increase of oxygen, that it had been spent in oxidising organic matter. No one will, of course, doubt that in a run of some twenty (English) miles between St. Denis and Meulan, some little oxidation takes place; but, as far as the figures go, the probability is the other way.

I only know of one report to the Local Government Board on the Caterham epidemic, that by Dr. Thorne Thorne. Supposing there is no other, I fail to see any connection between the question I asked and Dr. Thorne's report. As the latter has no reference to the chemical question, it cannot throw light on Capt. Galton's supposition that there had never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly, on analysis, have condemned the water as an impure source. It is scarcely necessary to say any more about this, as probably all chemists will agree that chemical analysis cannot get hold of the noxious ingredients of water polluted by infected sewage, and as there is further ample evidence that these noxious ingredients or specific poisons may spread disease, when present in quantities so minute that even the proportionately large quantity of other organic impurity, which always surrounds them, may fail to excite serious suspicion, however sensitive the analytical test may be.

GUSTAV BISCHOF.

4, Hart-street, Bloomsbury, W.C.
November 6, 1882.

Obituary.

GEORGE CRITCHETT, F.R.C.S.—The death of this distinguished surgeon took place on the morning of November 1st. He was born in 1817. He was the pupil of Mr. John Scott, surgeon to the London Hospital, and was apprenticed to the Royal College of Surgeons, of which he became a member in 1839, and a fellow in 1844. Shortly after obtaining his membership of the College of Surgeons, he was appointed Demonstrator of Anatomy at the London Hospital, where he afterwards became surgeon. Almost from the commencement of his career he was attached to the Royal London Ophthalmic Hospital, filling the posts of assistant-surgeon, surgeon, and consulting surgeon in succession. He also held the appointment of Ophthalmic Surgeon for some years at the Middlesex Hospital. In 1870, he was elected a member of the council of the College of Surgeons. He was President of the Hunterian Society during two years, Vice-President of the Ophthalmological Section of the International Medical Congress at London, in 1881, as well as Vice-President of the Ophthalmological Society. Mr. Critchett was also corresponding member of the Imperial Academy of Medicine of Rio de Janeiro, and an honorary member of the Academy of Medicine of Brussels. He introduced several new methods of great value into practice, and among various coutributions to the literature of the department he adorned, may be mentioned a course of "Lectures on Diseases of the Eye," published in the *Lancet* in 1854; a pamphlet on the "Operation for Strabismus by the Subconjunctival Method," including a new plan for correcting divergent strabismus by readjustment of the internal rectus muscle; a valuable Dissertation on the Linear Extraction of Cataract, read before the Ophthalmic Congress at Heidelberg in 1864; and a paper on the Treatment of the Superficial Affections of the Eye, read at the meeting of the British Medical Association in 1873. He became a member of the Society of Arts in 1856; and his brother, Mr. Charles Critchett, was for many years Assistant-Secretary, and afterwards Educational Officer to the Society. Mr. Critchett was a man whose personal character and kindness of heart had endeared him to a large circle of friends. His skill and conscientious care as an operative surgeon had, for many years, obtained for him a leading position not only among the operators of Great Britain, but among the ophthalmologists of the world. He lived through a period of progress in which the science and art cultivated so successfully by him have made unexampled strides. He saw the birth of the ophthalmoscope, the introduction of the new methods of research and operation for which we are so largely indebted to Helmholtz, Donders, Gräfe, Bowman, and Liebreich; and, in this progress, Mr. Critchett himself took an active part. During the latter years of his life he had been relieved of many of the cares and responsibilities of an arduous profession by his son, Mr. Anderson Critchett, Ophthalmic Surgeon to St. Mary's Hospital, who now succeeds him in his practice.

CAPTAIN WILLIAM GILL, R.E.—The Society of Arts has lost a distinguished member in the person of Captain Gill, who, there is too much reason to fear, has been (with his companions Professor Palmer and Lieutenant Charrington, R.N.), murdered in Africa, while on a mission from the British General. Captain Gill was elected a member of the Society in 1874, and he frequently attended the meetings, occasionally joining in the discussions. The son of Major Gill, of the Madras army, he was born at Bangalore in 1843. After obtaining his commission in the Royal Engineers, in 1864, he went to India, where he remained for several years. He first became known as a traveller in 1873, owing to his journey into Persia in company with Colonel V. Baker. Afterwards he made his celebrated journey through China, in consideration of which he received a gold medal from the Royal Geographical Society in 1879, and another from the Paris Geographical Society in the following year. Captain Gill's journal was published in 1880, under the title of "The River of the Golden Land."

Notes on Books.

THE MANUAL OF COLOURS AND DYE WARES: their Properties, Applications, Valuation, Impurities and Sophistications, for the use of Dyers, Printers, Drysalters, Brokers, &c. By J. W. Slater. Second Edition. London: Crosby Lockwood and Co. 1882.

This work is intended for the use of the three classes of makers, dealers and consumers, and for convenience of reference the whole has been arranged in dictionary form. Changes are so frequently taking place in the use of the various dyes, that it has been found necessary to dismiss, with a short notice, colours that were described at length in the former edition. Particular attention is paid the subject of adulteration, and modes for the detection of impurities and sophistications are given under the different headings.

ELEMENTARY DECORATION: a Guide to the simpler forms of Everyday Art, as applied to the interior and exterior Decoration of Dwelling-houses, &c. By James William Facey, jun. London: Crosby Lockwood and Co. 1882.

This little volume consists of thirteen chapters, in which the various points of decoration are discussed. Simple interior decoration is first treated of, and, from this, the reader is led on to advanced ornament and ceiling decoration. Exterior decoration is next dealt with, and the character of exterior polychromatic work, and the general treatment of the fronts of houses are discussed. There is also a chapter upon conservatory decoration.

COOKERY AND HOUSEKEEPING: a Manual of Domestic Economy for Large and Small Families. By Mrs. Henry Reeve. Third edition. Longmans, Green and Co. London. 1882.

This manual is not, as its title might seem to imply, a cookery-book of the ordinary type, containing only the usual instruction in the various branches of cooking, with recipes for the composition of dishes of different kinds. It is the work of a lady, who, after a long experience in housekeeping, has endeavoured to communicate to her readers the principles upon which she has learned to practice the art of domestic economy. The book, in the main, deals with a style of cookery that can only be aspired to where circumstances are easy, and means tolerably abundant. But among these, as a matter of fact, there are as many needing guidance in the circumstances they have to meet, as among the classes with pinched or limited means, for whom it is more common to provide books relating to household management. In a short chapter on "Expenditure," Mrs. Reeve gives some hints and rules for the ordering and determining of outlay, and for guarding against the possible frustration of a good design in this particular by the incapacity or unconscientiousness of servants. In this chapter she says:—"The mistress of the household should know what she means to spend, and should let the cook or housekeeper know that she has to deal with an intelligent and fair-dealing mistress." The series of recipes for dishes of all kinds is ample and well arranged; and several foreign dishes are included in the repertory. The more ambitious formulæ are properly addressed to thoroughly trained cooks, but there is also one chapter specially devoted to "homely fare," in which sketches of dietaries of that class, together with a considerable number of sample recipes, are given. There is a chapter entitled, "Defects in English Cookery." In the one which deals with the matter of costs, Mrs. Reeve states that fifteen shillings per week may be taken as the amount that the expenditure for each individual in a household should come to. This estimate includes the outlay for the servants' beer, and for the washing of the entire family; but, of course, not the cost for visitors and dinner parties. An English housekeeper, in Paris, gives sixteen shillings per head for each week for each individual, in a family where there are many children and servants. For a household where a handsome table is kept, and where there is neither stint nor excess, twenty shillings per week per head is held to be an adequate allowance.

SERIES OF CHRISTMAS CARDS. Published by Hildesheimer and Faulkner, 41, Jewin-street, E.C.

A large number of the cards issued for the present year are taken from designs which obtained the prizes offered by Messrs. Hildesheimer last year. These prize designs were exhibited in the Suffolk-street Galleries, in August, 1881. A considerable proportion of the cards represent flowers, both in groups and separate, but landscapes and figure pieces are also to be found in the collection. Among the artists whose works are here given, are Messrs. E. K. Johnston, George Marks, A. Glendinning, jun., E. Blair Leighton, W. Rathjeans, and Mesdames Victoria Dubouy, Aumonier, Duffield, and Ludovici.

General Notes.

DECORTICATION OF TEXTILE NETTLES.—It is remarked by the *Moniteur des fils et Tissus* that a great obstacle to the employment of the Chinese nettle for textile purposes has been the small proportion of the filaments, as compared with the size of the plant. The consequent difficulty of the extraction of that portion of the plant which is of commercial value, has tended to make the fibre in question relatively dear. By subjecting the plant to the action of steam, in a receptacle specially prepared the purpose, M. Farier effects the separation of the layers of bark and of resinous substance which surround the textile fibres. The extraction of the portion of the nettle which is of industrial value can then be easily effected, either by hand labour or by simple mechanical contrivances.

THE SPINNING INDUSTRY OF SWEDEN.—According to statistics, quoted in the *Moniteur des fils et Tissus*, there are in Sweden 24 cotton-spinning establishments, employing in all about 4,200 workpeople. The annual production is stated to have been as follows:—

	Kronors.	£ Sterling.
1876	14,393,884	799,660
1877	13,413,467	745,193
1878	10,713,363	595,116
1879	10,814,709	600,817
1880	12,042,424	669,024

The weight of the cotton yarn produced in 1880 is stated to have been 15,512,938 lbs. The flax spinning industry has shown a progressive development during the last five years. The out-turn of the two mills at Almedal and Jonserod amounted, in 1880, to 1,565,555 lbs. of linen yarn, of a value of 1,004,336 kronors, or £55,796. The total number of workpeople is 331. The wool spinning establishments were 63 in number in 1880, and there were in all 503 workpeople employed in this branch of the spinning industry. The quantity of yarn produced was 916,223 lbs., of a value of 1,187,527 kronors, or £65, 974. This result is almost twice as large as that which was attained during any of the four preceding annual periods.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 13...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. Edward Ryde.

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. A. R. Colquhoun, "Exploration through Southern China, from the Mouth of the Sikiang to the Banks of the Irawadi."

TUESDAY, Nov. 14 ..Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Major Allan Cunningham, "Recent Hydraulic Experiments."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Report on the Additions to the Society's Menagerie." 2. Mr. W. A. Forbes, "Supplementary Notes on the Anatomy of the Chinese Water-Deer." 3. Rev. L. Baron, "Notes on the Habits of the Aye-Aye of Madagascar in its Native State." 4. Mr. G. E. Dobson, "The Natural Position of the Family Dipodidæ."

WEDNESDAY, Nov. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Address by the Chairman of Council, Dr. C. W. Siemens.

Public Analysts, Burlington-house, 8 p.m. 1. Mr. A. H. Allen, "Notes on Commercial Albumen." 2. Dr. P. Vieth, "The Diminution of the Total Solids in Milk by Decomposition." 3. W. J. West-Knights, "The proportion of Dextrin to Maltose in Malt Worts."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. C. Roach Smith, "A Hoard of Bronze Bracelets at Brading, I.W. 2. Mr. C. H. Compton, "Antiquarian Features of the Recent Meeting of the Horners' Company."

THURSDAY, Nov. 16...Royal Burlington-house, W., 4½ p.m.

Chemical, Burlington-house, W., 8 p.m. Ballot for the election of Fellows. 1. "Contributions to the Chemistry of Tartaric and Citric Acids," by the late B. J. Grosjean. 2. Contributions from the Jodrell Laboratory, Kew:—(*a*) "Constitution of Lignin and Bastose," by C. F. Cross and E. J. Bevan; (*b*) "Contributions to the Chemistry of Plant Fibre," by C. F. Cross, E. J. Bevan, and S. S. Webster; (*c*) "Action of Nitric Acid on Cellulose," by C. F. Cross and E. J. Bevan. 3. Mr. R. Meldola, "The Constitution of some Bromine Derivatives of Naphthalene."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year:—

TRANSACTIONS, &c.

Aeronautical Society, Annual Report.
Amateur Mechanical Society, Journal.
American Chemical Society, Journal.
American Philosophical Society, Transactions.
American Society of Civil Engineers, Transactions.
Art Union of London, Report.
Bayerische Dampfkessel-Revisions-Verein, Bayerisches Industrie-und-Gewerbeblatt.
British Association for the Advancement of Science, Report.
British Association of Gas Managers, Report of the Proceedings.
British Horological Institute, Journal.
Charity Organisation Society, Reporter.
Chemical Society, Journal.
Chemico-Agricultural Society of Ulsher, Journal.
Colonial Institute, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geological Society, Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Proceedings.
Index Society, Publications.
India, Geological Survey of, Memoirs, Records, and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
Manchester Literary and Philosophical Society, Memoirs.
Manchester Steam Users' Association, Monthly Report.
Meteorological Society, Quarterly Journal.
Musée de l'Industrie de Belgique, Bulletin.
Musical Association, Proceedings.
National Association for the Promotion of Social Science, Sessional Proceedings.
National Indian Association, Journal.
National Life Boat Institution, Journal.
Pharmaceutical Society, Journal and Transactions.
Philadelphia Engineers, Club of, Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Report.
Royal Institution, Proceedings.
Royal Geographical Society, Proceedings and Journal.
Royal Irish Academy, Transactions and Proceedings.
Royal Scottish Society of Arts, Transactions.
Royal Society, Proceedings and Philosophical Transactions.
Royal United Service Institution, Journal.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Nationale d'Acclimatation de France, Bulletin Mensuel
Société des Sciences Industrielles de Lyon, Annales.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Transactions.
Society of Engineers, Transactions.
Society of Telegraph Engineers, Journal.
Statistical Society, Journal.
Victoria Institute, Journal.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Commissioners' of Patents Journal.

Weekly.

Agricultural Gazette.
American Architect and Building News.
American Gas Light Journal.
American Pottery and Glassware Reporter.
Architect.
Athenæum.
British Architect and Northern Engineer
British Journal of Photography.
British Mercantile Gazette.
Builder.
Builders' Weekly Reporter.
Building and Engineering Times.
Building News.
Capital and Labour.
Chemical News.
Chemiker-Zeitung.
Chemists' Journal.
Chronique Industrielle.
Colliery Guardian.
Colonies and India.
Cultura, La

Design and Work.
Draper.
Electrician.
Electricité, L'.
Empire.
Engineer.
Engineering.
English Mechanic.
European Mail.
Farmer and the Chamber of Agriculture Journal.
Furniture Gazette.
Gardeners' Chronicle.
Herapath's Railway Journal.
Inventors' Record and Industrial Guardian.
Irish Builder.
Iron.
Ironmonger.
Journal of Gas Lighting.
Journal d'Hygiène.
Land and Water.
Les Mondes.
London Iron Trade Exchange.
Mechanical World.
Medical Press and Circular.
Metropolitan.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Musical World.
Nature.
Photographic News.
Produce Markets' Review.
Queen.
School Board Chronicle.
Schoolmaster.
Scientific American.
Statist.
Temperance Record.
United States Patent Office, Official Gazette.
Warehousemen and Drapers' Trade Journal.

Fortnightly.

Art Interchange
Brewers' Guardian.
British and Colonial Printer and Stationer.
Finance Chronicle and Insurance Circular.
Gaceta Industrial.
Ingénieur Conseil.
Jeweller and Metal Worker.
Monde de la Science et de l'Industrie.
Moniteur de la Teinture.
Publishers' Circular.
Review of Gas and Water Engineering.

Monthly.

American Journal of Science.
Analyst.
Antiquary.
Art and Letters.
Artist.
Bibliographer.
Bookseller.
British Trade Journal.
Building Societies' Gazette.
Building World.
Cabinet Maker.
Canadian Patent Office Record.
Caterer, Hotel Proprietor and Refreshment Contractor's Gazette.
Chemist and Druggist.
Decoration.
Dyer.
Educational Times.
Electric Light.
Foreman Engineer and Draughtsman.
Gas Engineer.
Journal of Decorative Art.
Journal of Education.
Journal Telegraphique.
Leather Trades' Circular.
Machinery Market.
Magazine of Art.
Manufacturers' Review and Industrial Record.
Marine Engineer.
Mineral Water Trades' Review.
Monatsschrift für den Orient.
Moniteur Scientifique.
Nautical Magazine.
Orchestra and the Choir.
Paper Makers' Circular.
Photographic Times and American Photographer.
Pottery Gazette.
Planters' Gazette and Commercial News.
Revue Industrielle.
Revue des Industries.
Revue Maritime et Coloniale.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sanitary Engineering.
Sanitary Record.
Stationer.
Sugar Cane.
Symons's Meteorological Magazine.
Telegraphic Journal and Electrical Review.
Textile Manufacturer.
Watchmaker, Jeweller, & Silversmith's Trade Journal.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

NEWSPAPERS.

Bombay Gazette, Overland Summary.
Ceylon Observer & Weekly Summary of Intelligence.
Ceylon Times, Weekly Summary.
City (The)
City Press.
Eastern Post.
Home and Colonial Mail.
London and China Telegraph.
Nottinghamshire Guardian.
Sheffield and Rotherham Independent.
Staffordshire Sentinel.
Times of India (Overland Weekly Edition).

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